WORLD METEOROLOGICAL ORGANIZATION

RA IV HURRICANE COMMITTEE

TWENTY-EIGHTH SESSION

San Juan, Puerto Rico

(30 March to 4 April 2006)

FINAL REPORT

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION (Agenda item 1)

1.1 Opening of the session (agenda item 1.1)

1.1.1 At the kind invitation of the Government of the United States, the twenty-eighth session of the RA IV Hurricane Committee was held in San Juan, Puerto Rico from 30 March to 4 April 2006. The opening ceremony commenced at 0900 hours on Thursday, 30 March 2006.

1.1.2 Brigadier General David L. Johnson (retired), Director, National Weather Service (NOAA), opened the RA IV/HC-28 with the presentation "2005 Hurricane Season Wrap-up". General Johnson in his talk, emphasized the significant value of regional partnerships relating to data sharing for the success of the hurricane warning program and that cooperation among the NMHSs in the region remains of vital importance. He mentioned that the 5-day forecast has been found feasible, that improvement in track forecasts are indeed impressive but that intensity forecasts are still a concern. Further, he said that looking back on the Katrina experience, one sobering thought persists that a very good forecast may not be enough. Additionally, General Johnson outlined the various research and forecasting challenges we still face such as improving forecasts of intensity and landfall and improving understanding of long-term changes of overall hurricane activity. General Johnson concluded by stating that the Hurricane Committee is indeed a strength of the WMO and RA IV and urged RA IV Members to continue to work harmoniously together and further strengthen cooperation and collaboration.

1.1.3 The Chairman of the Hurricane Committee, Mr Max Mayfield (USA), welcomed all participants and stated that he looks forward to a productive session with the active participation of all those attending this years' session. He concluded by formally declaring the session open.

1.1.4 The session was attended by 40 participants, including those from 24 Members of the Committee, observers from Cape Verde, Spain and six Regional and International Organizations. The list of participants with the capacities in which they attended is given in **Appendix I.**

1.2 Adoption of the agenda (agenda item 1.2*)*

The Committee adopted the agenda for the session as given in **Appendix II.**

1.3 Working arrangements for the session (agenda item 1.3)

The Committee decided on its working hours and the arrangements for the session.

2. REPORT OF THE CHAIRMAN OF THE COMMITTEE (Agenda item 2)

2.1 The Chairman reported to the Committee that the RSMC Miami continued to assist the RA IV Members in the coordination of watches and warnings during 2005, the most active hurricane season on record. RSMC Miami is responsible for tropical and subtropical cyclone advisories for the North Atlantic Ocean, the Caribbean Sea, Gulf of Mexico and the North Pacific Ocean eastward from 140°W.

2.2 RSMC Miami will begin to issue operationally graphical (web) and text products providing the probabilities out to five days for 34, 50 and 64-kt wind speed thresholds during the 2006 hurricane season. The text product will provide probabilities at selected U.S. locations and at sites already provided to RSMC Miami by the WMO RA IV country members. The “Strike Probability” (WTNT71-75) text product has been discontinued and replaced by the tropical cyclone wind speed probability text products FONT1 (1-5) for the Atlantic basin and FOPZ1 (1-5) for the eastern North Pacific basin. An example of the graphical product is shown in **Appendix III**.

2.3 In the U.S., tropical cyclone forecasts are coordinated with the U.S. National Weather Service (NWS) Weather Forecast Offices and the Department of Defense (DOD) via a dedicated hotline. The Hurricane Liaison Team (HLT) is activated to assist with the coordination among state and federal emergency managers. Activation of a media pool during hurricane events continues to be a very efficient way of communicating the tropical cyclone forecasts in the U.S. The NOAA Hydrometeorological Prediction Center (HPC) in Washington provides rainfall guidance and is the backup for the RSMC Miami.

2.4 During the 2005 season, Emergency Managers (EM) were among the participants in the RSMC Miami attachment program. Mr. Alberto Munro (meteorologist) and Frank Philbert (EM) from Grenada; Mr. John Kennedy Tibbets (meteorologist) and Mr. Dwight McCleary Frederick (EM) from the Cayman Islands; and Mr. Marco Antonio Lugo (meteorologist) from Mexico participated in the program. The meteorologists helped improve hurricane warning coordination in the region during many of the tropical cyclone events while gaining valuable training in hurricane forecasting. The EMs had a unique opportunity to work with Federal, State and Local Emergency Management Agencies. They shadowed the Federal Emergency Management Agency (FEMA) HLT Coordinator at the National Hurricane Center who explained the role the HLT serves the emergency management community as well as general roles and responsibilities of FEMA. The EMs traveled to Tallahassee and spent two days at the Florida State Emergency Operations Center (EOC). They also visited the Miami-Dade EOC where they met with the staff and had an opportunity to discuss best practices. The Chairman hopes this program, designed to bring together representatives of both a country’s meteorological service and emergency management agency, will foster improved coordination. The RSMC Miami/WMO is asking WMO RA-IV Permanent Representatives and the directors of emergency management agencies to nominate candidates for the 2006 season. Members are requested to send the nominations to Lixion Avila for consideration.

2.5 Three meteorologists from the Mexican Air Force were stationed at the RSMC Miami during 2005. Cap. Javier Jimenez Camarillo and Majors Francisco Isidro Ramirez and Dario Raul Hernandez Ramirez coordinated timely clearances for hurricane surveillance and reconnaissance flights over Mexico during potential land falling tropical cyclone events. The aircraft clearances were particularly helpful as Hurricane Wilma stalled near and over the Yucatan Peninsula before heading for South Florida. Their efforts helped improve the overall efficiency of the Hurricane Warning Program. The Chairman hopes this program will continue in 2006.

2.6 The 2005 RA-IV Workshop on Hurricane Forecasting and Warning took place at the RSMC Miami from 11 to 23 April 2005. The workshop was conducted in English only. The 2006 RA IV Workshop on Hurricane Forecasting and Warning, conducted in English and Spanish, took place from 6 to 17 March 2006. The Chairman strongly feels that offering the bilingual workshop is important to the region’s hurricane program.

2.7 The Latin America Caribbean Hurricane Awareness Tour (LACHAT) took place from13 to 18 March 2006. The U.S. Air Force C-130 (J-model) hurricane hunter plane visited Chetumal, Mexico; Managua, Nicaragua; Curacao, Netherlands Antilles; Grenada and Mayaguez, Puerto Rico. The LACHAT successfully conveyed the importance of the team effort involved in the hurricane program and the need for advance planning in high-risk communities. The LACHAT enhanced the visibility of the individual country weather forecasting and emergency management offices. Slightly over 12000 people toured the plane. A Hurricane Awareness Tour (HAT) took place along the U.S. coast of the Gulf of Mexico from 2 to 6 May 2005. Another HAT is expected to take place along the U.S. east coast from 1 to 5 May 2006.

2.8 Reconnaissance aircraft continue to play an important role in monitoring the track and intensity of tropical cyclones. U.S. Air Force, NOAA Reconnaissance Hurricane and NOAA jet high altitude flights provided valuable meteorological data not available from other sources. Cooperation by all parties involved is fully appreciated.

2.9 Radar imagery received operationally via the internet primarily from Bahamas, Cuba, Mexico, France and the Netherlands Antilles proved extremely useful to the RSMC Miami in tracking tropical cyclones. The Chairman encourages members to make their radar imagery available operationally via the internet.

2.10 Surface and upper air observations are very important to the operational forecasts of the RSMC Miami. The Chairman appreciates the members' efforts to maintain their observation and communication systems. Observations from the automatic weather stations in the Bahamas and Mexico, and from the Mexican Navy were very useful during several tropical cyclones. Additionally, efforts by the HAM radio operators during the hurricane events were invaluable.

2.11 The Chairman thanks the members affected by tropical cyclones for the timely submission of their post-storm country reports. These reports are vital to the preparation of the RSMC Miami Tropical Cyclone Report.

2.12 U.S. Congressional hurricane supplemental funds after the 2005 hurricane season provided 4 new hurricane specialist positions to the RSMC Miami and the building of eight new buoys to track tropical cyclones. The proposed location of these new buoys along with the locations of buoys deployed after the 2004 hurricane seasons are shown in **Appendix IV.**

2.13 As part of the United States Weather Research Program (USWRP) the Joint Hurricane Testbed (JHT) continues to evaluate research projects with the goal of transitioning successful projects into operations. To date 10 projects have been transitioned to operations and 27 additional projects are being currently evaluated and/or considered for implementation.

2.14 Lixion Avila is serving as the Chairman of the American Meteorological Society (AMS) Tropical Committee until 2008 and is chairing a group to produce a new AMS Tropical Meteorology and Hurricane Statement.

2.15 The Chairman was pleased that 15 members of the WMO RA-IV attended the AMS Annual meeting in Atlanta, Georgia from 30 January to 3 February 2006. The 15 RA IV members joined colleagues from around the world in participating in the AMS International Session on Multi-Hazards Warning Systems. The AMS International Session brought together representatives of National Hydrological and Meteorological Services (NHMS), the private sector, and international finance and aid organizations to discuss current operational infrastructure to formulate and disseminate multi-hazards warnings, and the role of the national meteorological and hydrological services in the development of multi-hazards warning systems.

2.16 The next International Workshop on Tropical Cyclones (IWTC-VI) is scheduled for 21 to 30 November 2006, in San Jose, Costa Rica. Lixion Avila continues to represent RA IV in the international organizing committee. Candidates from the region have been submitted to the IWTC-VI Chairman and to WMO for consideration. Planning and coordination for the meeting are currently in progress.

2.17 Given that RSMC Miami has tropical cyclone forecast and coordination responsibilities for the entire North Atlantic Ocean, the Chairman appreciates the WMO's efforts to ensure that Spain and Cape Verde fully benefit by inviting a representative from each country to participate as an observer to the RAIV Hurricane Committee Meetings.

2.18 Lixion Avila visited the Institute of Meteorology of Spain during March 2006 and gave several lectures on hurricane track and intensity forecast as well as on the use of RSMC Miami products. Lixion provided input to a plan for the formation of a tropical meteorology unit within the Institute of Meteorology of Spain.

2.19 Additionally, the U.S. National Weather Service has been engaged in other capacity-building efforts within the region. February 13-15, 2006, 24 participants from WMO RA IV (including the United States) met in Miami to discuss the adoption of a Caribbean Protocol. The aim of the Protocol is to develop a regional plan/protocol for cooperation and coordination between countries in the region for managing emergencies primarily during severe weather/natural events (e.g., hurricanes/tropical storms, earthquake/tsunami) but also for any problems where an NMHS may need operational support.

2.20 The meeting in Miami also served as a venue to discuss the progress of the 2004 Hurricane Supplemental and Reconstruction plans. In September 2004, The White House approved FY2004 emergency supplemental proposals, totaling over $7.1 billion, for the Departments of Agriculture, Commerce, Defense, Homeland Security, the Interior, Justice, Transportation and Veterans Affairs; as well as the Corps of Engineers, International Assistance Programs, and the Small Business Administration. Of this, $14.7 million was requested for the National Oceanic and Atmospheric Administration (NOAA) to repair facilities, to address impacts to endangered species and their habitat, and to provide necessary upgrades to hurricane forecasting assets. Of this, U.S. NWS Office of International Activities received $324,500 for a strategy involving four components:

(a) equipment repair/replacement in affected Caribbean countries;

(b) organization of a reconstruction workshop to develop a draft strategy for the reconstruction efforts in the Caribbean;

(c) develop a Caribbean regional "protocol" for emergency management cooperation / coordination during severe weather events; and

(d) on-the-job training for emergency managers from the Caribbean countries to work with FEMA, Florida state, and local emergency managers to improve coordination between local Caribbean NMHSs and their local emergency management agencies.

2.21 In March 2005, U.S. NWS received Hurricane Supplemental Funds in the amount of $324,500. Procurement Requests for observational instrumentation were issued in October 2005: (a) one for Riverside Technology, Inc. (RTi) to provide training and installation of automated weather station equipment for Swan Island, Honduras; and (b) one for equipment purchases for all five countries and labor charges (Grenada, Jamaica, Bahamas, Cayman Islands and Honduras). It is anticipated that Swan Island will be up and operational sometime in spring 2006. It is anticipated that most of the other countries will receive requested equipment, but it is unlikely that there are sufficient funds to enable all countries to become operational. Therefore, an assessment will be required once the Hurricane Supplemental funds are expended to determine additional funding needs from the Third Border Initiative (TBI).

2.22 In 2001, President Bush developed the TBI, which is "designed to enhance diplomatic, economic, health, education and law enforcement cooperation and collaboration" between the U.S. and our Caribbean neighbors. Part of this initiative includes an increase in funding for

"Disaster Preparedness and Mitigation efforts to shield critical commercial and environmental infrastructure from natural disasters, such as hurricanes." In June 2005, an updated proposal was submitted for TBI funding, "NOAA All-Hazards Disaster Preparedness," requesting $500,000 for a two-component strategy:

- to enhance, renovate, and rehabilitate the hydrometeorological monitoring network throughout the region, including upper-air and surface observational systems as well as hydrometeorological and sea-level monitoring networks (i.e., tide-gage networks). Renovation and rehabilitation of the hydromet systems in the Bahamas (Abaco, Cat Island, Mayaguana, and San Salvador), Cayman Islands, Grenada, Jamaica, and Honduras (Swan Island) will ensue under the Congressional hurricane supplemental funds (although it is anticipated that there will be insufficient funds to cover all the countries' needs).

- to enhance, renovate, and rehabilitate the telecommunications network throughout the region, including the development of a satellite-based natural-hazard information network as part of the existing NOAA Emergency Managers Weather Information Network (EMWIN) and upgrading Internet capabilities where possible.

2.23 In September 2005, NOAA received confirmation that funding would be provided in the amount of $452,000. Implementation plans are currently in development.

3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME (Agenda item 3)

3.1 The Committee was informed that the WMO Executive Council at its fifty-seventh session (Geneva, June 2005) recognized that one of the most effective measures for disaster preparedness is a well-functioning early warning system that delivers accurate and *user-friendly* information in a timely manner. To this effect, the Council endorsed the targets set by the TCP Expert Meeting on Effective Early Warnings of Tropical Cyclones (Kobe, Japan, January 2005) for:

- All TC RSMCs and TCWCs to strive to increase the accuracy of track and intensity forecasts of tropical cyclones by 10% by 2015. The Council noted the difficult challenge of attaining the intensity goal based on current research;

- All TC RSMCs, TCWCs and concerned Members of tropical cyclone regional bodies to issue probabilistic forecasts of tropical cyclones up to 5 days by 2015;

- Members of tropical cyclone regional bodies to educate stakeholders *annually* on proper interpretation of tropical cyclone forecasts, advisories, warnings and other meteorological and hydrological information; and

- Members of tropical cyclone regional bodies to ensure dependable and effective dissemination of tropical cyclone nowcasts, forecasts, advisories, watches and warnings in real-time to decision-makers including emergency managers, media, general public and other stakeholders.

3.2 The Committee was also informed of the various activities carried out during the intersessional period within the programme under both the general and regional component.

3.3 Noting the importance of workshops on storm surge and wave forecasting and that such had been held and are planned in other TCP regional bodies, the Committee requested WMO to likewise arrange such workshops for Members of RA IV possibly in 2007.

3.4 In response to a question from the Committee pertaining to the technical report on the Wind Averaging Guidelines submitted by the Systems Engineering Australia Pty. Ltd. (SEA) to WMO, the WMO Representative informed the Session that the recommendations/comments expressed by the Fifth TC RSMC/TCWC Coordination Meeting (Honolulu, December 2005) had not yet been addressed to by SEA. The Committee urged WMO to endeavour on getting the technical report finalized as soon as possible preferably before the start of the 2006 Hurricane Season.

3.5 As coordination with Haiti during the Hurricane Season is of vital importance, the Committtee requested that WMO ensure that the country be represented in future Committee sessions. It noted with appreciation that the Dominican Republic and France (Martinique) will assist WMO in this regard.

4. REVIEW OF THE PAST HURRICANE SEASON (Agenda item 4)

4.1 Summary of the past season (agenda item 4.1)

4.1.1 A report of the 2005 hurricane season in the Atlantic basin and in the Eastern North Pacific was presented to the Committee by Dr Lixion Avila, Hurricane Specialist, on behalf of RSMC Miami - Hurricane Center.

RSMC Miami 2005 Atlantic Hurricane Season Summary

4.1.2 The 2005 Atlantic hurricane season was the most active on record. Twenty-seven named tropical storms formed, breaking the old record of 21 set back in 1933. Fifteen storms became hurricanes, breaking the old record of 12 set back in 1969. Seven of the hurricanes became major hurricanes, (category three or higher on the Saffir-Simpson hurricane scale) including four, Emily, Katrina, Rita, and Wilma, which reached Category Five intensity. This is the first time since 1851 that four category five hurricanes have been known to occur in a season. Wilma had a minimum central pressure of 882 mb, which is the lowest ever measured in an Atlantic hurricane. The season also included three depressions that did not reach tropical storm strength, and one system currently under review to determine if it was a subtropical storm. For comparison, based on data from the last 40 years, an average season consists of 11 named storms, 6 hurricanes, and 2 major hurricanes.

4.1.3 Seven tropical cyclones made landfall in the United States, including Hurricanes Cindy Dennis, Katrina, Rita, and Wilma. The latter four were major hurricanes, and this was the first time of record that four major hurricanes hit the U. S. in one season. Katrina devastated portions of the northern coast of the Gulf of Mexico and is the costliest U. S. hurricane of record. Additionally, Katrina is the deadliest U. S. hurricane since the Palm Beach-Lake Okeechobee hurricane of September 1928. Hurricane Ophelia also affected the U. S., although the circulation center stayed just off the coast of North Carolina. Seven tropical cyclones also hit Mexico, including major hurricanes Emily and Wilma. Dennis hit Cuba as a major hurricane, while Hurricane Beta hit Nicaragua and the Colombian island of Providencia. Vince made landfall in Spain as a tropical depression, making it the first tropical cyclone on record to hit that country.

RSMC Miami 2005 Eastern Pacific Hurricane Season Summary

4.1.4 Tropical cyclone activity in the eastern North Pacific basin in 2005 included 15 named tropical storms. Seven of the tropical storms became hurricanes and only one (Kenneth) became a major hurricane (category three or stronger on the Saffir-Simpson hurricane scale) in the basin. One of the hurricanes (Jova) reached major hurricane status after crossing into the central Pacific basin. As in 2004, the activity was below average in terms of the numbers of hurricanes and major hurricanes. The long-term seasonal averages are: 15 tropical storms, 9 hurricanes, and 4 major hurricanes. There was one additional depression in 2005 that did not reach tropical storm intensity. None of the tropical storms or hurricanes made landfall. Adrian was the only cyclone to make landfall and it did so in Honduras as a weakening tropical depression.
4.1.5 The summary report on the 2005 hurricane season provided by the RSMC is given in **Appendix V.**

4.2 Reports on hurricanes, tropical storms, tropical disturbances and related flooding during 2005 (agenda item 4.2)

4.2.1 Many members provided the Committee with reports on the impact of the season's tropical cyclones and other severe weather events in their respective countries. With respect to Hurricanes Adrian, Alpha, Arlene, Beta, Cindy, Dennis, Emily, Franklin, Gamma, Harvey, Katrina, Nate, Ophelia, Philippe, Rita, Stan, Tammy and Wilma, representatives of Bahamas, Barbados, Bermuda, British Caribbean Territories (BCT) (Cayman Islands), Colombia, Cuba, Dominican Republic, El Salvador, Guatemala, Jamaica, Mexico, Nicaragua, Trinidad and Tobago and USA provided the Committee detailed informative reports.

4.2.2 The summary reports on the 2005 hurricane season provided by Member countries are given in **Appendix VI.**

5. COORDINATION IN OPERATIONAL ASPECTS OF THE HURRICANE WARNING SYSTEM AND RELATED MATTERS (Agenda item 5)

5.1 The Committee agreed to the Chairman's proposal that Mr Tyrone Sutherland (BCT) serve as rapporteur on this agenda item. The Committee considered several matters raised by its members that have an impact on the effectiveness of the Hurricane Warning System, as well as special presentations by invited experts, particularly in light of the record-breaking 2005 hurricane season.

5.2 In this regard, the representative of France described a new system for displaying local warnings within the French West Indies (FWI), which comprise the islands of St. Barthelemy, the French part of the island of St. Martin, Guadeloupe and Martinique, as well as French Guiana on the South American coast in RAIII. It was recalled that the French Meteorological Service (Météo-France) briefed the 27th session of the Committee in 2005 on the early development of this system. The new system utilizes a new colour-coded scheme to describe the four types and four levels of alert and related emergency procedures for various meteorological hazards within the FWII, as published by Météo-France and is designed for use by emergency managers, decision-makers, industry and the public.

5.3 Météo-France indicated that an extensive public information and education programme in the FWI had been undertaken to introduce the new system, and that the system could be accessed in real-time on its webpage **www.meteo.gp.** The meeting noted the introduction of such a scheme for the FWI, and also noted that the alert system, as described and displayed on the website, would not display regular forecasts or non-tropical cyclone hazards and alerts for the non-French islands. However, the Committee expressed serious concern that the system did not alleviate the potential for major confusion among the public and officials in the non-FWI, because of the size and close proximity of the islands, which may be at different levels of alert in tropical cyclone-related situations. In this regard, the Committee noted the assurance by Météo-France that the system would display tropical cyclone hazards and alerts for the non-FWI only as and when published by RSMC-Miami, using the definitions in the Hurricane Committee's Operational Plan. Nonetheless, the Committee made mention of the special case in the island of St. Maarten-St. Martin, where different agencies have responsibility for alerts and warnings on the Dutch and French parts of the island, and requested Météo-France to ensure that its display took this matter into account in an attempt to avoid conflict and confusion with official alerts and warnings for the Dutch side of the island. The Committee further recommended that Météo-France include a disclaimer on its graphic version of the scheme to indicate that Météo-France is only responsible for forecasts and warnings for St. Barthelemy, French St. Martin, Guadeloupe, Martinique and French Guiana.

5.4 Météo-France also provided the Committee with information concerning the upgrade of the European Centre for Medium-range Weather Forecasts (ECMWF) numerical models. It indicated that ECMWF upgraded its forecasting system from the **1st of February 2006**, in which the deterministic model featured a T799 truncature (rough horizontal resolution: 25 km) with 91 levels and the Ensemble Prediction System (EPS) with a T399 truncature with 62 levels. The table below shows the related changes in the dissemination schedule as a result of the upgrade:

Deterministic	**Until 31 January**	**From 1st February**
Analysis	HH+06.45	HH+05.50
Day 1	HH+07.15	HH+06.05
Day 5	HH+07.55	HH+06.35
Day 10	HH+08.45	HH+07.15
EPS		
Day 0	HH+09.35	HH+08.25
Day 10	HH+10.15	HH+09.05
Where HH is the hour of the run, 00 UTC or 12 UTC		

5.5 The invited expert from the Meteorological Institute of Spain made a presentation to the Committee on the impact Hurricane Vince and Tropical Storm Delta on its territory during the 2005 hurricane season. Hurricane Vince passed to the northwest of the Madeira Islands on 9 October then weakened to tropical depression before making landfall on the Spanish mainland on 11 October, producing strong winds and heavy rain. Tropical Storm Delta hovered near the Azores and then as a vigorous extra-tropical low pressure system near the Canary Islands in late November. It produced wind gusts of hurricane force in the Canary Islands on 28 November, before affecting Morocco. The Spanish Meteorological Institute reported that there were several deaths and extensive damage to the power supply in the Canary Islands.

5.6 The Spanish Meteorological Institute received special assistance from the RSMC - Miami in dealing with the warnings for its territory related to these systems. After the hurricane season, RSMC Hurricane Specialist Dr Lixion Avila visited Spain to assist in setting up a coordination procedure between the RSMC and Spain in case of future events of this kind. The Hurricane Committee endorsed the request of Spain to have bulletins or special information on these systems from the RSMC in the Spanish language, and urged the RSMC to explore options in this regard. The Committee was very pleased that the RSMC-Miami offered to host a Weather Forecaster from Spain in its hurricane season attachment programme. It was also suggested that Spain should contact the WMO Secretariat to try to have one of its forecasters on the next RA IV Workshop on Tropical Cyclone Forecasting in 2007.

5.7 The Hurricane Committee recognized that the passage of tropical cyclones over the Eastern Atlantic Ocean, whether originating in the hurricane areas of RA IV or the waters off Africa (RA I) and Europe (RA VI), required wider coordination of warnings between RSMC - Miami and the appropriate European bodies, particularly the Météo-France Marine Centre in Toulouse, France, which has responsibility for marine forecasts and warnings in that area. The area of marine responsibility of Météo-France is shown in **Appendices VII and VIII.** It was agreed that the Operational Plan should include contact numbers for Spain and the Météo-France Marine Centre in Toulouse.

5.8 Two crew members of the US Air Force Reserve 53rd Weather Reconnaissance Squadron, Lt Col Dave Borsi and Major Jason May, made an excellent presentation on operational aspects of hurricane reconnaissance in RA IV. The presentation described the key coordination role of the RSMC Miami for all reconnaissance flights in the region, conducted by both the Air Force Reserve and the NOAA hurricane reconnaissance missions. The crew described the Air Force Reserve Hurricane Mission, made up of round-the-clock operations capable of handling three storms at a time, which continued to demonstrate the invaluable need for data collected within the storm systems for transmission by the aircraft directly to the RSMC-Miami Hurricane Center. The flight patterns flown, which are described in the RA IV Hurricane Operational Plan, and the types of data acquired for input into the hurricane warning system were discussed. These include:

- *Low Level Investigation Flights* for wind field patterns, eyewall structure and central pressure details;
- *High Altitude Synoptic Tracks* to determine system steering currents;
- *Sea State Buoy Deployments*.

5.9 It was also revealed that the quality of the data collected was expected to increase drastically, specifically winds at the surface to ten meters above the surface, once the Air Force reconnaissance aircraft were fitted with Stepped-Frequency Microwave Radiometers (SFMR). The use of the SFMR was scheduled for testing on the Air Force planes late on the 2006 hurricane season. At the same time, the crew described some of the challenges to hurricane hunter in-flight operations, which included:

(i) breaks in communication with Air Traffic Control;

(ii) clearance from some Air Traffic Control Centres;

(iii) avoiding conflict with other air traffic; and

(iv) ensuring diplomatic clearance for flights over some countries of the region.

The representative of the BCT offered to obtain and provide to the reconnaissance teams, via the RSMC, the Air Traffic contact points in the Flight Information Regions (FIR) in the English-speaking Caribbean. The Meeting also proposed that future Latin America Caribbean Hurricane Awareness Tours (LACHAT), by both Air Force and NOAA, should include exchange visits between Air Traffic facilities and officials and the Hurricane Reconnaissance aircraft to foster greater awareness and understanding.

5.10 The RSMC - Miami Hurricane Center provided the Meeting with details of the new wind speed probabilistic forecasts to be introduced for the 2006 hurricane season. The Committee recalled that in 2005, the Chairman had introduced the forecasts in the experimental phase.

After reviewing the RSMC probabilistic forecast used up to the 2005 hurricane season, the RSMC indicated that the new probability forecast would provide an improved means of conveying tropical cyclone forecast uncertainties to various types of users. The new forecast would continue to be provided in a graphical webpage format and text format for selected locations on the Atlantic, Caribbean and Eastern Pacific coasts. The new product, which would be available on the RSMC website, would provide, among others, greater guidance on the chances of a certain location being affected by a particular tropical cyclone, for which several examples were given. The Committee was briefed on some of the challenges and ongoing work with the new forecast product, which include:

- The need for significant training and outreach;
- Enhancement of graphic products;
- Potential use by forecast offices, field offices and other users;
- Use for forecast verification;
- Objective guidance for watch and warning breakpoints (geographic areas);
- The provision of gridded products for the US National Digital Forecast Database (NDFD).

5.11 In discussing specifics of the Hurricane Warning System in 2005, the Committee noted that the various attachments to the RSMC from countries in the region played a major role in improving RSMC hurricane warning coordination in the region. The RSMC felt, however, that maximum mutual benefit of the presence of these meteorologists and emergency officials was not always possible during the periods of excessive hurricane activity experienced in the season.

5.12 The Committee discussed methods to avoid potential coordination problems between the RSMC and individual National Meteorological Services (NMSs). It strongly recommended that staff at all offices must be fully familiar with the details of the RA IV Hurricane Operational Plan, and reminded the NMSs with warning responsibility that coordination telephone calls with the RSMC could be initiated by either party concerned.

5.13 The Committee was very pleased with details of the ocean buoys being deployed by the USA to help track tropical cyclones in RA IV. It noted that seven buoys had been deployed after the 2004 hurricane season and that plans were for eight new buoys to be built in the near future. The operational buoys (see Appendix IV) could be accessed through the RSMC Miami Web site link or directly through the web site of the US National Data Buoy Center at **www.ndbc.noaa.gov**, along with other buoys shown in the Operational Plan.

5.14 The USA briefed the Committee on its proposals to upgrade the NOAA Emergency Managers Weather Information Network (EMWIN) that is in use in the South Pacific (WMO Region V) and parts of the Caribbean (Region IV). The Committee expressed its appreciation to the USA for this initiative and noted that an increasing number of NMHSs were interested in acquiring EMWIN for use as a redundant component within their main telecommunication system, or within their national emergency management system. The Committee stressed, however, that priority in the upgrade and/or deployment of new EMWIN units should be given to the islands without Forecast Offices in the region, since the EMWIN was their main system for reception of data, as well as those with firm plans for their use in Emergency Management.

5.15 As was normal during every session, the Hurricane Committee reviewed the published names of the tropical cyclones used in both the Atlantic and eastern North Pacific Basins, in case there was any need for changes. Because of the record-breaking 2005 hurricane season, in which the list of assigned names had been exhausted and the Greek Alphabet was used for the first time in the Atlantic Basin, there was considerable discussion on the use of the Greek Alphabet. Many views were expressed on whether a significant storm that was designated by a Greek letter could be retired into history, as is done with regular names. It was generally agreed that the use in 2005 of the Greek Alphabet had a major important political, economic and social impact globally, which may not have been the case if a supplemental list of regular names had been used after exhausting the normal list. The Hurricane Committee therefore unanimously decided that the Greek Alphabet would continue to be used.

5.16 In this connection, The Committee also agreed that it was not practical to “retire into hurricane history” a letter in the Greek Alphabet. It therefore decided that if a significant storm designated by a letter of the Greek Alphabet, in either the Atlantic or eastern North Pacific Basin, were considered worthy of being “retired”, it would be included in the list of retired names with the year of occurrence and other details, but that the particular letter in the Greek Alphabet would continue to be available for use in the future. The Committee agreed that the criteria for inclusion of such storms in the list would be the same as those for the retirement of regular names, and that the header of Tables III and IV in Chapter 9 of the Hurricane Operational Plan would be amended to include “…and Significant Storms designated by a letter of the Greek Alphabet” with a footnote indicating the criteria for inclusion.

5.17 This year, the Committee was requested to retire the names Dennis, Katrina, Rita, Stan, and Wilma from the Atlantic list because of the damage and deaths associated with those hurricanes in 2005. Bearing in mind the discussion at the 27^{th} session of the Hurricane Committee on the need for a more even distribution of English, Spanish and French-based names, and the desire that names should be short and easy to pronounce in any language, the Committee decided to:

- replace Dennis with **Don**;
- replace Katrina with **Katia**;
- replace Rita with **Rina**;
- replace Stan with **Sean**; and
- replace Wilma with **Whitney**.

These new names would be submitted to the President of RA IV for approval and inclusion in the Hurricane Operational Plan, appearing in the rotating list of names in 2011.

6. REVIEW OF THE RA IV HURRICANE OPERATIONAL PLAN (Agenda item 6)

6.1 Under this agenda item, the Committee designated Mr Patrick Jeremiah (Antigua and Barbuda) (Vice-chairman and representative of English speaking members) and Dr José Rubiera Torres (Cuba) (Vice-chairman and representative of Spanish speaking members) to serve as rapporteurs. Mr William Appleby (Canada) accepted to serve as a coordinator for ATTACHMENT 8 A (LIST OF TELEPHONE NUMBERS OF NATIONAL METEOROLOGICAL SERVICES AND KEY OFFICIALS) to the RA IV Hurricane Operational Plan.

6.2 The Committee reviewed in depth the Operational Plan, taking into account changes and additions, which came out from the other agenda items, in particular on item 5 above.

6.3 The Committee was informed that the 2005 version of the Hurricane Operational Plan is available online at:

http://www.wmo.ch/web/www/TCP/OperationPlans/TCP30-English2005.pdf

6.4 The Committee recommended to the President of RA IV the approval of the amendments to the text of the Plan. The Committee urged the WMO Secretariat that these amendments and changes made to the Plan should be posted to the TCP Web site both in English and Spanish, before commencement of the 2006 hurricane season.

6.5 Météo-France (Martinique) agreed to update the translation of the new 2006 edition in French and to distribute it to Haiti.

7. REVIEW OF THE COMMITTE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2006 AND BEYOND (Agenda item 7)

(a) The Committee designated Mr P. Jeremiah (representative of English-speaking members) and Dr J. Rubiera Torres (representative of Spanish-speaking members) to serve as rapporteurs;

(b) A detailed review of all components of the Technical Plan and its Implementation Programme was carried out, taking into account the development and progress made by Members since the twenty-seventh session of the Committee. The updated RA IV Hurricane Committee's Technical Plan and its Implementation Programme, which awaits the approval of the President of RA IV is given in **Appendix IX.**

7.1 Meteorological Component (agenda item 7.1)

7.1.1 The Committee noted that the review of the meteorological component of the Plan focused on the status of implementation of the World Weather Watch (WWW), the need for additional data, facilities and arrangements for the purpose of tropical cyclone detection, monitoring and forecasting, and on the modernization of the tropical cyclone warning system through regional coordination and cooperation.

Global Observing Systems

7.1.2 The Committee was informed that Regional Basic Synoptic Network (RBSN), being a minimum regional requirement to permit Members to fulfill their responsibilities within the World Weather Watch (WWW), continued to provide essential support for hurricane detection and warning services. During the intersessional period and resulting from the fourteenth session of RA IV (San José, Costa Rica, 2005), the number of surface stations in the RBSN increased by 29 stations and the number of upper–air stations decreased by 7 stations. However, the number of automatic marine stations remained unchanged. The current RBSN consists of 541 surface stations, 136 upper-air stations and 25 automatic marine stations. It should also be noted that during intersessional period the status of implementation (main standard hours) of the RBSN stations remained stable at 90 per cent for surface observations and increased up to 99 per cent (93 per cent in 2004) for upper-air observations.

7.1.3 The Annual Global Monitoring (AGM) of the operation of the WWW provides information on the performance level of the observing and telecommunications systems. According to the results of monitoring carried out in October 2005, 358 stations (66 per cent) out of the total number of RBSN surface stations were providing more than 90 per cent of expected SYNOP reports. A total of 110 stations (20 per cent) were providing between 45-90 per cent of expected reports and the number of stations providing less than 45 per cent of expected reports comprised 26 stations (5 per cent). An alarming tendency is the increasing number of "silent" stations 47 (29 in 2002, 32 in 2004) stations, constituting almost 9 per cent of the total number of RBSN surface stations. It was noted that some gaps in the SYNOP data coverage continue to exist over certain areas in the southern part of the Region (Bahamas, Clipperton, Guatemala, Haiti, Nicaragua and Venezuela).

7.1.4 The availability of upper-air data from the RBSN stations according to the AGM results in October 2005, indicated that 112 stations (82 per cent) out of the total number of RBSN upper-air stations were providing more than 90 per cent of expected TEMP reports. 10 stations (7 per cent) were providing between 45 – 90 per cent of expected reports and 7 stations (5 per cent) were providing less than 45 per cent of expected reports. It was noted however, that the number of "silent" stations decreased to 7 (11 in 2004) stations, constituting 5 per cent of the total number of RBSN upper-air stations.

Aeronautical Meteorology

7.1.5 The Committee was informed that in Region IV, two of the most important operational AMDAR programmes are running, namely the US programme providing respectively about 150,000 AMDAR observations per day from 6 commercial carriers involving a total of 2,150 AMDAR fitted aircraft and the Canadian programme providing about 25,000 observations per day from a fleet of 58 aircraft serving 67 destinations in Canada and the USA.

7.1.6 A notable deficiency of the AMDAR system compared to the conventional radiosonde is its inability to report humidity. However, a technical milestone has been reached in this regard with the laser diode water vapour sensor (WVSS II) developed by the USA successfully deployed on 25 B-757 aircraft in 2005. A field assessment of the WVSS II was conducted in June 2005 to compare WVSS II soundings with among others co-incident radiosonde data and GPS and other sensors. Future plans for the WVSS II sensor include the monitoring of its performance under real environmental conditions in order to validate the sensor availability and performance. The WVII sensor is also being evaluated by several countries in various regions of the world including European countries, Australia, New Zealand and South Africa.

7.1.7 The development of the US TAMDAR integrated sensor that includes temperature, winds, humidity, Eddy Dissipation Rate (EDR) based turbulence and icing detection culminated with the successful regional deployment of the sensor on 60 SAAB-340 aircraft in early 2005. Various assessments of TAMDAR data are being conducted including field assessments, case studies of data impacts to short-term forecasts as well as sensitivity studies to numerical models.

7.1.8 The Committee noted that although all modern passenger jets are already equipped with the AMDAR system and also that many developing countries do already have these aircraft, many airlines still do not operate the AMDAR system mainly because of added telecommunication costs. In the midst of an era of decreasing radiosonde station, the Committee urged WMO and ICAO to send a strong message on the needs of the Meteorological Services especially those in developing countries in order to facilitate negotiation with the airline operators for the use of the AMDAR system in every flight.

Meteorological Satellites

7.1.9 The session noted that NOAA had launched NOAA-18 in May 2005 and although NPOESS had experienced some complications in its development, it was anticipated that a way forward would be identified by mid-2006. At the end of 2005, the two nominal operational satellites were NOAA-17 and NOAA-18, with NOAA-15 and NOAA-16 still sufficiently effective to act as backup. NOAA-12 and NOAA-14 still have some functionalities (NOAA-12: AVHRR, SEM and Argos; NOAA-14, the last satellite of the 4th generation, still has HIRS/2, SSU, SEM, Argos and SARSAT operable).

7.1.10 The GOES programme is designed to cover two positions (GOES-W at 135°W, GOES-E at 75°W) by two satellites, with one common backup satellite in an intermediate position (105°W) to be moved as a replacement in case of failure of the other two satellites. Until the end of 2005, GOES –10 (135°W) and GOES-12 (75°W) were in operational status. GOES-11 is the current standby satellite at 105°W. GOES-N which was tentatively scheduled for launch in March 2006 had been re-scheduled for a May 2006 launch and the next generation GOES series (GOES-R) is making good progress.

7.1.11 NOAA plans to move GOES-10 to enhance coverage of the Americas. By significantly improving satellite detection of such natural hazards as severe storms, floods, drought, landslides, and wildfires, the move would help protect lives and property in North, Central, the Caribbean and South America. The move would further strengthen the WMO's World Weather Watch Global Observing System.

Marine Meteorology and Oceanography

7.1.12 The Committee was informed that the 9th International Workshop on Wave Hindcasting and Forecasting would be held in Victoria, Canada, 24 to 29 September 2006 and will have as its focus the so-called extreme storm seas.

7.1.13 The Global Maritime Distress and Safety System (GMDSS (forming a part of SOLAS) covering the Region are fully operational, useful and satisfactory to the mariners. A new Web site for the project (http://weather.gmdss.org) is providing real-time both regional and global marine forecasts and warning broadcast. Regional members continue to provide extensive support for climatic projects like Marine Climatological Summaries Scheme (MCSS), the Global Digital Sea Ice Data Bank (GDSIDB) and the Global Temperature Salinity Profile Programme (GTSPP) as well as for observational projects of VOS, SOOP, GLOSS, and the ASAP and WRAP programmes.

7.1.14 There is a constant regional contribution, including that from Canada and USA, to the ARGO drifting buoy programme and to the programmes related to data-sparse ocean areas, like South Atlantic Buoy Programme (ISABP), the North Pacific Data Buoy Advisory Panel (NPDBAP), and the International Arctic Buoy Programme (IABP) and the International Programme for Antarctic buoys (IPAB). The Argo array is dramatically increasing and is expected to reach its target of 3,000 operating floats in 2006/2007 and the ARGO Information Center (AIC, http://argo.jcommops.org/) is actively participating in the activities of the JCOMM *in situ* Observing Platform Support centre (JCOMMOPS). Implementation of the Argo project of sub-surface profiling floats is now well underway. Data are freely made available in real-time through Argo GDACs and through the GTS.

7.1.15 The First Session of the IOC Intergovernmental Coordination Group (ICG) for Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions was held in the United Nations House, Bridgetown, Barbados between 10 and 12 January 2006. Venezuela offered to host the second ICG Session that would be held in December 2006, outside the hurricane season. WMO is supportive of the initiative to develop the Tsunami Early Warning and Mitigation System in Wider Caribbean. An active participation and involvement of the NMHSs in the Caribbean region was coordinated. The ICG recognized the WMO-GTS as the backbone global telecommunication mechanism for the exchange of multi-hazards, observations, and information and warnings, including tsunami warnings and alert information. As the session recommended that strong links be established between the ICG, the Hurricane Committee and the National Hurricane Centre in Miami (USA), which is one of WMO's Regional Specialized Meteorological Centres, the ICG was invited to participate in this session. Unfortunately, no response was received by WMO. However, a representative of USA made a presentation on Tsunami during the meeting.

EMWIN

7.1.16 The Committee noted with thanks the information provided in a presentation on the use of EMWIN in the Caribbean as part of the Third Border Initiative (TBI) and the outcome of the TBI meeting held in Miami, Florida, USA in February. The presentation also outlined the use of TBI funds to conduct a Pilot EMWIN demonstration test at the beginning of the 2006 Hurricane season in the June timeframe and the advantages of EMWIN as a supplemental dissemination system. Taking advantage of the GOES satellites to disseminate Watches & Warnings, graphics, and text data on a priority driven basis with Watches & Warnings receiving the highest priority. Of note is that Hurricane product is included in the current EMWIN data stream having been added in 2005, and successful tests have been conducted with the Alaska Tsunami center adding Tsunami warnings. EMWIN is a fairly inexpensive system when compared to other dissemination systems, that provides a constant, priority driven system with no recurring charges. EMWIN used as a backup or supplementary system to the countries regular GTS communications system can provide a robust system that is fairly resistant to severe weather conditions, does not have the problem that Internet access receives in severe weather instances and with solar or battery backup can continue to receive data during power outages.

7.2 Hydrological Component (agenda item 7.2)

7.2.1 The Committee was informed that WMO so far, regional workshops under WMO's flood forecasting initiative had been held in South Africa in November 2003 and for RA III (South America) and RA IV (North, Central America and the Caribbean) in Valencia, Spain, in March 2004.

7.2.2 The meeting in Valencia had been co-organized with the National Meteorological Service of Spain and was attended by experts from meteorological and hydrological services of the Ibero-American countries of RA III and IV. As a result of the meeting the Valencia Declaration was issued and a network of experts from these countries was established. A first meeting of the network was held in July 2005 in Santo Domingo, Dominican Republic, under the Title: International course on the basis of monitoring and forecasting hydrometeorological phenomena. A second meeting was held in Lima, Peru, in October 2005 with the title: Ibero-American workshop on Flooding and Natural Disasters.

7.2.3 In this respect, the Chairman of the Working Group on Hydrology (WGH) informed the Committee that an international workshop on flash flood forecasting was held in San José, Costa Rica from 13 to 17 March 2006. This workshop was co-organized by WMO and NOAA. Over 100 participants attended the workshop which focused on the importance of establishing end to end warning systems and experts discussed new approaches to predicting flash floods in remote regions. The NOAA/Hydrologic Research Center Central America Flash Flood Guidance (CAFFG) system was demonstrated as part of the workshop and served as an example of a technology that can be applied to a country, regional or global level . A summary report of the workshop was distributed to participants and posted on the NOAA and WMO websites. As part of the workshop, three demonstration flash flood warning projects were agreed on to be established in Colombia, Argentina and in the Caribbean.

7.2.4 It is recalled that XIV-RA IV had re-established the WGH (Resolution 13). The Association in its resolution included the Terms of Reference of five subgroups: Training and continuing education, hydrological warning systems, integrated water resources management, development of CARIB-HYCOS and Transboundary Water Resources Management. The Chairman of the WGH is also the Regional Hydrological Adviser and as such participated in the last session of the Executive Council. He also has prepared the 2005 annual report on the activities carried out in the Region in relation to the Hydrology and Water Resources Programme. Due to the non-availability during 2005 of the report of the RA IV session in the two working languages of the Region, there has been some delay in proposing to the President of the Regional Association names of the coordinators of the five sub-groups mentioned above. The Chairman of the WGH will make this proposal as soon as possible. In spite of the fact that there are no coordinators, one of the two activities included in the terms of reference of the sub-group on Integrated water resources management, namely one Workshop on the Application of the UNESCO/WMO publication "Water Resources Assessment – Handbook for Review of National Capabilities" was held with the support of UNESCO for most of the Spanish-speaking countries of RA IV in Bogóta, Colombia in February 2006. Later this year, WMO will support a similar workshop for English-speaking countries of RA IV. This second workshop will also be coordinated with UNESCO.

7.2.5 The subgroup on warning systems conducted a survey of member countries on the availability and operation of hydrologic warning systems. This inventory now sets the stage for the committee to establish a strategy to expand warning system implementations and to strengthen existing warning systems to the region.

7.2.6 The Committee was pleased to note that NOAA is receiving some funds from the U.S. State Department's Third Border Initiative(TBI) which will result in deployment of some observing equipment and deployment of Emergency Management Weather Information Network (EMWIN) Systems in selected CARICOM countries.

7.2.7 The WGH is planning to have its next meeting in 2006 in El Salvador. Plans are now underway to develop a detailed agenda, meeting location arrangements and participants.

7.2.8 Another CHy project under implementation is the preparation of the Manual on Flood Forecasting and Warning. A meeting of most of the contributors to the preparation of the Manual was held in Beijing, China in November 2005. The Chairman of the RA IV Working Group on Hydrology (WGH) is one of the contributors. Another expert of RA IV is also participating in the preparation of the Manual.

7.3 Disaster Prevention and Preparedness Component (agenda item 7.3)

7.3.1 The Committee noted with interest the activities of WMO's DPM Programme:

- Integration of cross-cutting activities of all relevant WMO Programmes to address systematically and sustainably priorities and gaps in WMO's disaster prevention and mitigation activities in all six regions;
- Facilitation of strategic partnerships to strengthen the linkage between scientific and technical activities of WMO with the disaster risk management community; and
- Capacity building in hazard mapping provision of data products and related expertise in support of risk assessment activities for hazards related to weather, climate and water.

7.3.2 The Committee was informed that WMO took a leading role in the recently concluded Third International Early Warning Conference (EWC III) sponsored by the Government of Germany, and was from 27 to 29 March 2006. Furthermore, WMO is participating in the Global Early Warning Survey, the Global Survey of the Early Warning Systems requested by the UN Secretary General, Kofi Annan, in his report to the General Assembly "In Larger Freedom: towards development, security and human rights for all", A/59/2005, 21 March 2005.

7.3.3 WMO is planning a "meeting of experts" on "Multi-Hazard Early Warning Systems for Integrated Disaster Risk Management," to be held on 23-24 May 2006, at WMO Headquarters in Geneva, Switzerland. This symposium is aimed to build on the critical momentum generated from the WCDR, the results of the Global Early Warning Survey and the Third International Early Warning Conference, hosted by Germany on 27-29 March 2006 in Bonn, Germany. This meeting will be co-sponsored by several members of the ISDR - Interagency Task Force (ISDR-IATF) that are involved in different aspects of early warning systems. The Symposium is a multi-disciplinary expert meeting to discuss major challenges and recommend an implementation framework, with concrete actions at international, regional and national levels for implementation of "Multi-Hazard Early Warning Systems". During this multi-disciplinary expert meeting, among other issues, challenges related to legal, legislative and policy, financial, organizational, scientific and technical, operational, training and capacity building aspects will be discussed.

7.3.4 The Meeting noted that the Hurricane Committee in RA IV is an excellent platform for strengthening the linkages among the scientific agencies to enhance early warnings for tropical cyclones, storm surges and coastal flooding for integrated coastal disaster risk management in this region. Furthermore, the Meeting noted that the Hurricane Committee in RA IV could also serve as a very important platform for strengthening linkages with relevant regional agencies and national agencies involved the area of integrated disaster risk reduction.

7.3.5 The Meeting noted the opportunity for the Hurricane Committee to collaborate with the WMO Natural Disaster prevention and Mitigation Programme to document its contributions and lessons learned over the last many years to reducing the loss of life and property caused by tropical cyclones and storm surges in this region, with particular attention to coordination of activities and collaborations with the disaster risk management authorities.

7.3.6 The Meeting noted that in 2007, DPM Programme would be compiling a portfolio of *good practices*, particularly related to integration of hydro-meteorological early warnings as an integral part of natural disaster prevention and mitigation activities.

7.3.7 Cognizant of the fact that the tsunami hazard exists in all ocean basins including the Caribbean, the Members were pleased to note that WMO will invite a representative from the Intergovenmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions to the next meeting of the Committee.

7.3.8 The Committee recognized the important role of NMHSs in the establishment of a multi-hazard warning system in the Region including for tsunami warnings. However, the Committee also emphasized that there is a need to come to a clear definition of the responsibilities of the NMHSs in this connection.

7.3.9 Dr Yuichi Ono from the United Nations International Strategy for the Disaster Reduction (UN/ISDR) informed the Hurricane Committee on key elements of the 'Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disaster.' The ISDR highly encouraged the Committee to take a key role for the implementation of the Hyogo Framework in the area of hurricane-related disasters in the region. He made a briefing on the outcomes of the EWC III and emphasized the importance of the 'last mile' issues in early warning systems. He informed the Committee that the Global Survey of Early Warning Systems indicates dissemination, preparedness, and response capacities are weaker than technical monitoring capabilities in early warning systems. Thus, it is highly recommended to continue inviting regional disaster managers and experts to future Hurricane Committee meetings. He also introduced the Town-Watching practice developed by the Asian Disaster Reduction Center, Japan as one of the practical solutions to assist communities for better evacuation in response to early warning.

7.4 Training (agenda item 7.4)

7.4.1 The Committee reviewed the participation of its Members in various education and training activities supported under WMO Voluntary Co-operation Programme (VCP), Regular Budget (RB), and Trust Fund arrangements.

7.4.2 The Committee expressed appreciation for the number of training events and workshops, which were organized during the year 2005 for the benefit of its Members. The Committee noted that its Members had benefited from WMO's education and training activities, relating to the award of fellowships, relevant training courses, workshops, seminars, the preparation of training publications, and the provision of advice and assistance to Members.

7.4.3 The Committee noted that WMO fellowships for long-term and short-term training continued to be granted to the Member countries of the Committee under the various WMO programmes.

7.4.4 The Committee expressed its gratitude to all those Members who made available their training facilities and/or experts to other Members under bilateral or any type of arrangements. These cooperative efforts by the Committee Members have been found by the recipient countries to be very useful. It thus strongly recommended that such endeavours should continue in the future and be strengthened. The Committee urged its Members to make maximum use of such training facilities.

7.4.5 The Committee noted the recent development of the Education and Training Programme (ETRP) Website and the current initiatives to facilitate online access to worldwide training resources, as well as exchange of meteorological case studies and related documentation between advanced and less advanced training institutions.

7.4.6 The Committee took note of the information regarding the current status of the E-learning MSc in Meteorology programme for RA IV.

7.4.7 The Committee was informed that an Atmospheric Science Programme had just started at the University of Puerto Rico at Mayaquez and that a full bachelor's degree would be in place in 2009/20010. The Committee was pleased to note that the said programme is available for the whole region.

7.4.8 The Session expressed its appreciation to Dr Colin Depradine of the Caribbean Institute for Meteorology and Hydrology (CIMH) for his invaluable contribution over many decades to the Hurricane Committee in particular, to the training activities of RA IV.

7.5 Research (agenda item 7.5)

7.5.1 The Committee was informed that the International Workshop on Tropical/Extra-tropical Interaction, incorporating IWET-III was held in Perth, Australia in December 2005 to develop a scientific plan, which focused on extra-tropical transition of tropical cyclones in conjunction with the Pacific THORPEX Regional Campaign and the International Polar Year during 2008. This project would contribute to improving further safety and to reducing the economic losses of land-falling tropical cyclone affected countries.

7.5.2 The Committee was pleased to note that steps are underway to organize the Sixth International Workshop on Tropical Cyclones (IWTC-VI), which will be held in San Jose, Costa Rica from 21-30 November 2006 with the theme "Quantitative Forecast Guidance for Tropical Cyclone Landfall in Relation to an Effective Warning System", which was considered by the Panel to be a timely topic given the devastation caused by tropical cyclones in both the Atlantic and the Pacific in 2005. The Hurricane Committee is represented by Dr Lixion Avila (USA) in the International Committee for IWTC-VI, which is responsible for preparation and organization of the Workshop. Operational and research meteorologist from RA IV who are able to fund themselves to the IWTC-VI should, in a timely manner, inform Dr Avila of their intent to attend the said workshop.

7.5.3 Following a request of the 27th session of The Hurricane Committee in 2005, the Secretariat made a presentation on THORPEX. THORPEX, meaning **<u>TH</u>**e **<u>O</u>**bserving system **<u>R</u>**esearch and **<u>P</u>**redictability **<u>Ex</u>**periment, was established by the 14th World Meteorological Congress (2003) as a ten-year international global atmospheric research and development programme under the auspices of the WMO Commission for Atmospheric Sciences (CAS). THORPEX is a component of the WMO World Weather Research Programme (WWRP).

7.5.4 THORPEX is intended to accelerate improvements in the accuracy of 1-day to 2-week high impact weather forecasts for the benefit of society, the economy and the environment. The Experiment is geared to reduce and mitigate natural disasters by transforming timely and accurate weather forecasts into specific and definite information in support of decisions that produce the desired societal and economic outcomes. Specifically, THORPEX aims at:

1) Extending the range of skilful weather forecasts to time scales of value in decision-making (up to 14 days) using probabilistic ensemble forecast techniques;
2) Developing accurate and timely weather warnings in a form that can be readily used in decision-making support tools;
3) Assessing the impact of weather forecasts and associated outcomes on the development of mitigation strategies to minimize the impact of natural hazards.

7.5.5 THORPEX will undertake a series of regional and global projects, focusing specifically on the extra-tropical and tropical Pacific and Atlantic, the Pacific-Indian Ocean warm pool, and Polar regions. At the moment, THORPEX had three Regional Committees for (i) North America, (2) Europe and (3) Asia. The Hurricane Committee noted that the objectives of THORPEX were consistent with the aims of the WMO/ICSU *International Workshop on Tropical Cyclones* (IWTC), which is to improve the accuracy of predictions for high- impact tropical cyclones. As the Committee members were still not very clear on the benefits of THORPEX for the tropical areas and how the Hurricane Committee could play a role, it requested the WMO Secretariat to try to schedule a presentation and discussion on THORPEX at the next IWTC scheduled for Costa Rica late in 2006, and for THORPEX experts to clarify these issues to the 2007 session of the Hurricane Committee.

8. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE COMMITTEE'S TECHNICAL PLAN AND STRENGHTNING OF THE OPERATIONAL PLAN (Agenda item 8)

8.1 The Committee reviewed the assistance, pertinent to the implementation of the Technical Plan or strengthening of the operational plan, provided to Members since the Committee's twenty-seventh session and considered the plan for future action.

8.2 The Committee expressed its satisfaction that WMO, through the Department of Regional Activities and Technical Cooperation for Development (RCD), with the support of the WMO Subregional Office in Costa Rica (North, Central America and the Caribbean, (NCAC), has continued developing TCO activities to ensure cost-effective services to Members. Activities have focused mainly on the promotion of technical projects in the Region, as well as on the follow-up of ongoing ones. The Subregional Office has also provided support to regional activities and assistance in the implementation of WMO Programmes in the Region. The Committee was informed of the following projects:

Trust Fund projects

8.3 The regional project – "Preparedness to Climate Variability and Global Change in Small Island Developing States, Caribbean Region" funded by the Government of Finland was completed in 2004 with measurable success in the implementation of all components.

8.4 Considering the capacity created by the SIDS-Caribbean Project, the results achieved and the interest expressed by the participating countries through the Association of Caribbean States, the Government of Finland approved US$ 445,000 for the development of a pilot project on Automated Weather Service Production System for the Caribbean Area using the capacity that is now available in the region. The pilot project will be implemented in 2006 in Cuba, Jamaica and Trinidad and Tobago and extended later to selected NMS in the Caribbean region.

8.5 The pilot project is expected to contribute to the sustainability, visibility and development of the Meteorological Services and allow the establishment of partnerships offering better products and services to potential partners (public and private sectors).

8.6 In 2005, the implementation of the large scale Water Resources Management Project (PROMMA) was concluded. During the project implementation, a total of 223 technical reports were prepared and disseminated for its use in the National Water Commission of Mexico. The NMS of Mexico through the PROMMA project was benefited, improving weather and climate forecasts and training skills of personnel In addition to meteorology, the PROMMA project also covered the areas of operation hydrology, groundwater, water quality, water resources planning and sustainable use of groundwater. WMO also provided assistance to the National Water Commission of Mexico for the preparation of the Fourth World Water Forum that took place in Mexico City in March 2006.

Regional activities

8.7 The Committee was informed that:

- The XIV Regional Association Meeting was held in San Jose, Costa Rica from 5 to 13 April 2005. One of the main results of the meeting was the establishment of the Management Group of the Regional Association IV to advise and assist the president on matters related to the work of the Association.
- The WMO continued to collaborate with the various economic and technical organizations in the development and implementation of meteorology programmes and projects in RA IV.
- The radar networking system project supported by the European Union has continued being implemented under the coordination of the CMO. The project will benefit the Caribbean region providing early warnings on hurricanes and severe weather.
- As a result of the International Conference for the Establishment of a Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions held in Mexico D.F. in June 2005, the UNESCO and IOCARIBE, and other related organizations, including WMO, called for a second meeting. This meeting was held in Bridgetown, Barbados from 10 to 12 January 2006 to establish an Intergovernmental Coordination Group for Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions. The WMO taking into account that the Caribbean and the adjacent regions are very sensitive to natural disaster impacts, decided to promote the participation of NMSs in the above mentioned meeting so that the NMSs of the Caribbean region could become involved in the evolution of the Tsunami Early Warning System. Ten representatives of the NMSs of the Caribbean Region attended the meeting and important conclusions emanating from the meeting emphasized the active role of the WMO and the NMSs in the process.
- The RAMSDIS System that provides, in real time, high-resolution satellite imagery and products continue its execution with great success. These images and products are provided by the Instituto Meteorologico Nacional of Costa Rica to the rest of the Central American countries via internet. The System is supported by the United States Government and the Universidad de Costa Rica and assisted by the WMO.
- The WMO and the World Water Partnership are developing a bi-national project on Integrated Flash Flooding System for the Sixaola river basin between Costa Rica and Panama. WMO is executing the project through its Department of Hydrology and Water Resources and with the assistance of the Subregional Office. The project is expected to be concluded by the middle of 2006.

- The WMO, through the Space Programme Office, and the University of Costa Rica have in operation a Centre of Excellence in meteorological satellites at the University of Costa Rica, and its main activities are: Organize training seminars, update and disseminate satellite methods for image reception, promote the use of satellite information in the NMSs, disseminate training material and to promote the participation of the focal points of the WMO Virtual Laboratory, in weather discussions in real time.
- The First International Workshop on Flash Flood Forecasting was hosted by Costa Rica's National Meteorological Institute (IMN) in San José and participants agreed that an international road map to reduce the impacts of flash floods through flash flood warning cooperation should be implemented, reaffirmed the need for an end-to-end flash flood warning system to reduce the impacts of flash floods, agreed to maintain a platform for the exchange of knowledge, information and technology (including experts) while strengthening all elements of the flash flood forecasting and warning system, agreed on the need for advanced data observing systems, computer models, communication systems and response planning, and launched testing and application of advanced technologies through region specific demonstration projects of high national and international interest such as the Central American Flash Flood Guidance (CAFFG), funded by the USAID, through NOAA, which was successfully implemented on a dissemination server at the IMN in Costa Rica. The CAFFG functions as regional (international) guidance system, collecting and producing national operational information for all Central American countries and will be replicated, with the USAID/NOAA sponsorship, in the Mekong river basin and South Africa. These projects are focused on attracting donor support.

Training

8.8 The Committee noted that the WMO, the University of Costa Rica and the University of Oslo had commenced a Masters Degree Programme in Hydrology with strong emphasis on distance and computed aided learning components. The programme started with 10 students from Costa Rica, El Salvador, Guyana, Panama and 3 students from the University of Oslo. The creation of a similar e-learning MSc degree in Meteorology is in the planning stage in RA IV.

8.9 The Committee also took note that the RMTC of Costa Rica has continued its support of multimedia and computed aided learning for continuing education by translating COMET's modules on Ensemble Forecasting, Aviation Weather, Climate Change, Hurricane Strike, Hydrology, Satellite Meteorology, Numerical Weather Prediction into Spanish.

8.10 The Committee noted that several countries in the region have installed meteorological radars recently and others are in the process of installing them. Therefore, the Committee stressed the need to increase radar related training activities in the region.

Assistance to NMHS

8.11 The Committee was informed that the WMO, through RCD Department and the Subregional Office have assisted Guatemala in the reformulation of the modernization project for the NMHS. Also WMO, with the assistance of Spain, have been working to rehabilitate the operative capacity of the meteorological and hydrological observing network in Guatemala after Hurricane Stan.

VCP projects

8.12 In 2005, three VCP project requests were submitted by Bahamas, Barbados and El Salvador. Upper-air consumables (GPS radiosondes) were provided to Costa Rica by USA under funding from the US Climate Change Research Initiative for the enhancement of global climate atmosphere observing systems. A VCP project for the replacement of the RA IV RMTN workstation was completed in Honduras. An electrolytic hydrogen generator was provided for the upper-air station in Dominican Republic with the support of USA.

8.13 Inspite of considerable support obtained during 2001-2005, 12 valid projects have not yet received funding support as os 31 January 2006. The list of VCP projects for RA IV Hurricane Committee Members is given in **Appendix X.**

8.14 During 2005, 20.1 person x months of fellowships were awarded within the framework of the VCP.

9. SCIENTIFIC LECTURES AND DISCUSSIONS (Agenda item 9)

9.1 The following scientific lectures were presented during the session:

- RA IV Hurricane Committee Report on Caribbean Reconstruction and TBI - Curtis Barrett (USA)
- Third Border Initiative (TBI) EMWIN Pilot Project - Edward Cormier (USA)
- The Indian Ocean Tsunami: People on Beaches were a Large Part of Devastating Loss of Life - Bill Proenza (USA)
- Hurricane Tracking Chart in Braille - Ismael Figueroa, Puerto Rico's Office of Persons with Disabilities (USA)

9.2 The lectures were followed by discussions in which all actively participated.

10. DATE AND PLACE OF THE TWENTY-NINTH SESSION (Agenda item 10)

10.1 The delegate from the Netherlands Antilles and Aruba informed the Committee that his country would consider hosting the twenty-ninth session of the RA IV Hurricane Committee in Curaçao in 2007.

10.2 The Committee, in welcoming the information and accepting this offer, expressed its warm appreciation to the Government of the Netherlands Antilles and Aruba.

11. CLOSURE OF THE SESSION (Agenda item 11)

The report of the twenty-eighth session of the Committee was adopted at its final meeting at 1000 hours on 4 April 2006.

LIST OF APPENDICES

APPENDIX I

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APPENDIX II

AGENDA

1. ORGANIZATION OF THE SESSION

   1.1 Opening of the session
   1.2 Adoption of the agenda
   1.3 Working arrangements for the session

2. REPORT OF THE CHAIRMAN OF THE COMMITTEE

3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME

4. REVIEW OF THE PAST HURRICANE SEASON

   4.1 Summary of the past season

   4.2 Reports of hurricanes, tropical storms, tropical disturbances and related flooding during 2005

5. COORDINATION IN OPERATIONAL ASPECTS OF THE HURRICANE WARNING SYSTEM AND RELATED MATTERS

6. REVIEW OF THE RA IV HURRICANE OPERATIONAL PLAN

7. REVIEW OF THE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2006 AND BEYOND

   7.1 Meteorological Component
   7.2 Hydrological Component
   7.3 Disaster Prevention and Preparedness Component
   7.4 Training Component
   7.5 Research Component

8. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE COMMITTEE'S TECHNICAL PLAN AND STRENGTHENING OF THE OPERATIONAL PLAN

9. SCIENTIFIC LECTURES AND DISCUSSIONS

10. DATE AND PLACE OF THE TWENTY- NINTH SESSION

11. CLOSURE OF THE SESSION

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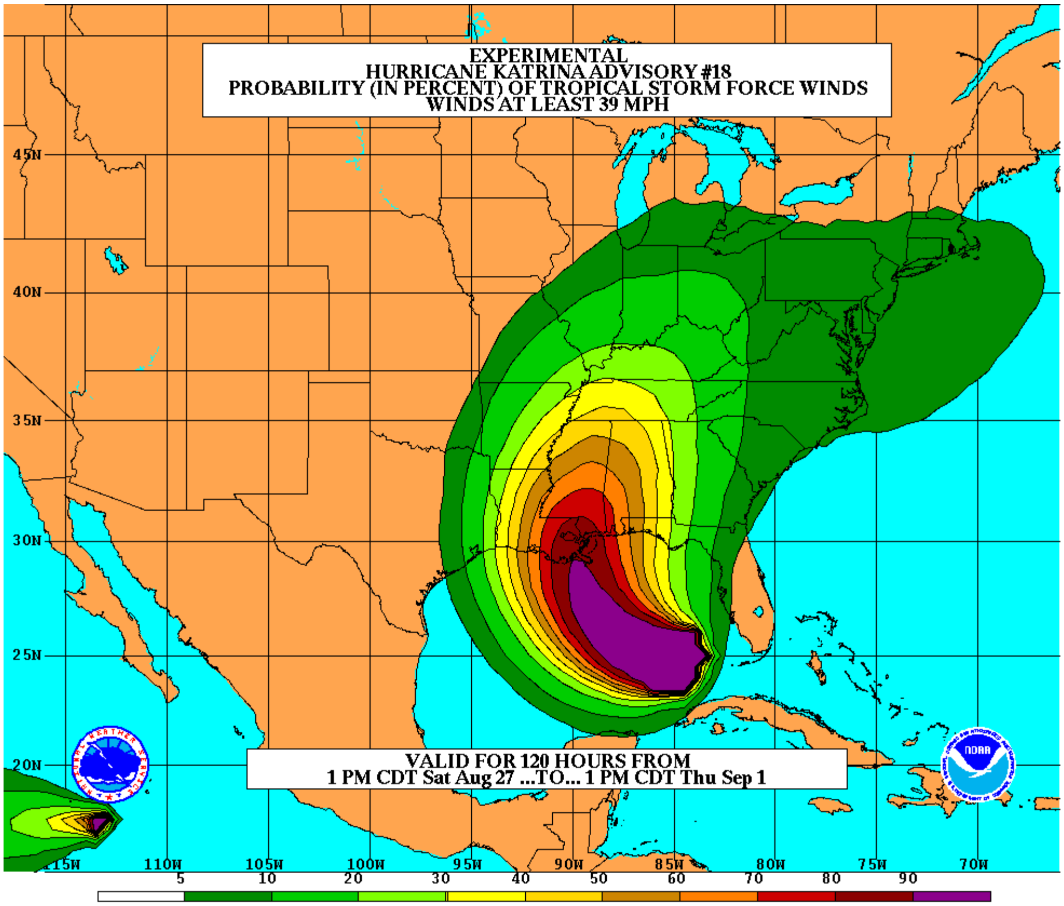
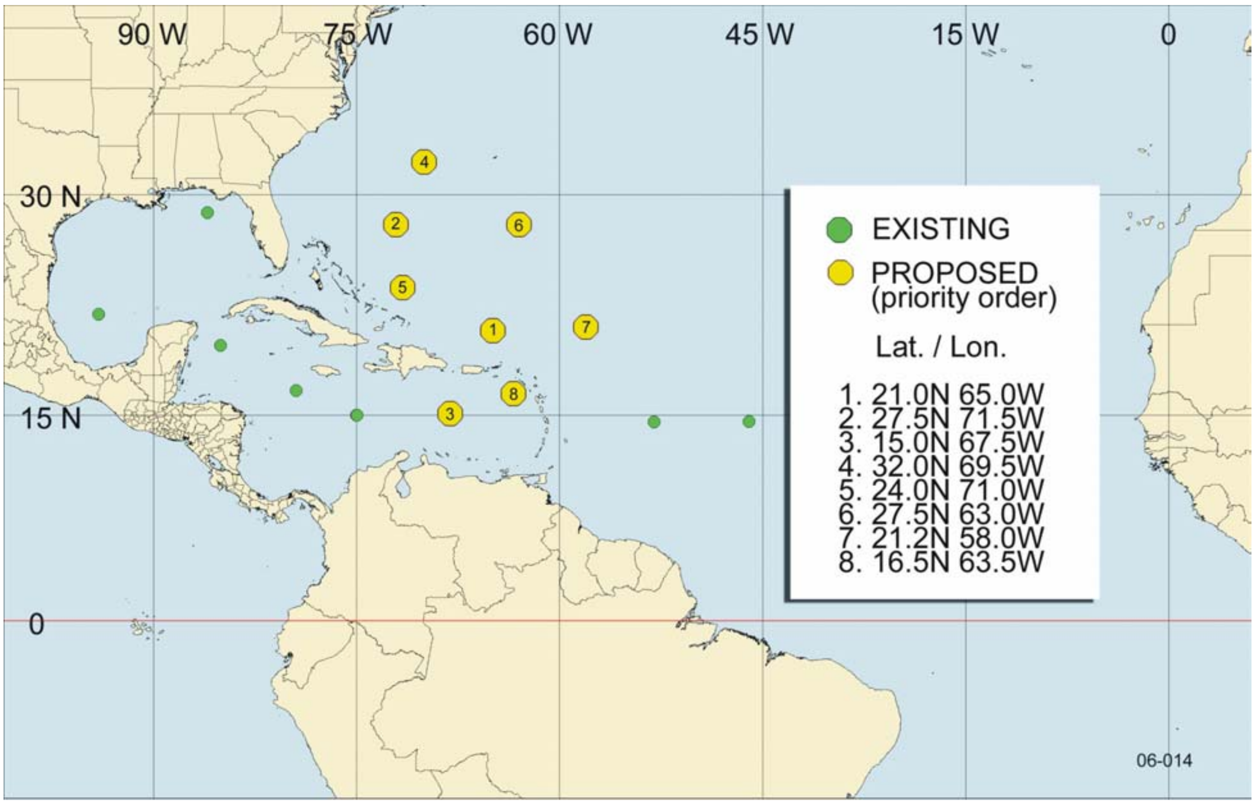
APPENDIX III



Strike Probability Graphical Product

APPENDIX IV

OCEAN BUOYS DEPLOYED AND TO BE DEPLOYED BY THE USA TO HELP TRACK TROPICAL CYCLONES IN RA IV



APPENDIX V

2005 ATLANTIC AND EASTERN NORTH PACIFIC HURRICANE SEASON SUMMARY

(Submitted by RSMC Miami)

Atlantic

The 2005 Atlantic hurricane season is the most active on record. Twenty-seven named tropical storms formed, breaking the old record of 21 set back in 1933. Fifteen storms became hurricanes, breaking the old record of 12 set back in 1969. Seven of the hurricanes became major hurricanes, (category three or higher on the Saffir-Simpson hurricane scale) including four, Emily, Katrina, Rita, and Wilma, which reached Category Five intensity. This is the first time since 1851 that four category five hurricanes have been known to occur in a season. Wilma had a minimum central pressure of 882 mb, which is the lowest ever measured in an Atlantic hurricane. The season also included three depressions that did not reach tropical storm strength, and one system currently under review to determine if it was a subtropical storm. For comparison, based on data from the last 40 years, an average season consists of eleven named storms, six hurricanes, and two major hurricanes.

Seven tropical cyclones made landfall in the United States, including Hurricanes Cindy Dennis, Katrina, Rita, and Wilma. The latter four were major hurricanes, and this was the first time of record that four major hurricanes hit the U. S. in one season. Katrina devastated portions of the northern coast of the Gulf of Mexico and is the costliest U. S. hurricane of record. Additionally, Katrina is the deadliest U. S. hurricane since the Palm Beach-Lake Okeechobee hurricane of September 1928. Hurricane Ophelia also affected the U. S., although the circulation center stayed just off the coast of North Carolina. Seven tropical cyclones also hit Mexico, including major hurricanes Emily and Wilma. Dennis hit Cuba as a major hurricane, while Hurricane Beta hit Nicaragua and the Colombian island of Providencia. Vince made landfall in Spain as a tropical depression, making it the first tropical cyclone of record to hit that country.

In the individual storm descriptions, all dates and times are UTC.

Tropical Storm Arlene

Arlene formed as a depression on 8 June near the northeastern coast of Honduras from the combination of a tropical wave and the Intertropical Convergence Zone. The depression became a tropical storm on the 9 June about 170 miles west-southwest of Grand Cayman. Arlene moved slowly northward with steady intensification and crossed western Cuba near Cabo Corrientes with winds of 50 mph. The storm continued northward over the eastern Gulf of Mexico where it reached its peak intensity of 70 mph. Thereafter, Arlene weakened and made landfall near Pensacola, Florida on 11 June with 60-mph winds. The cyclone continued to weaken as it moved northward farther inland and was absorbed by a frontal system on 14 June over southeastern Canada.

Punta del Este, on the Isle of Youth, Cuba, reported sustained winds of 47 mph at 0725 UTC 10 June, while Navarre, Florida reported a gust of 60 mph at 1910 UTC 11 June. One student died in a rip current triggered by Arlene at Miami Beach, Florida. The storm caused minimal damage.

Tropical Storm Bret

Tropical Storm Bret originated from a tropical wave accompanied by a weak area of surface low pressure that crossed Central America and the Yucatan Peninsula of Mexico from 24-27 June. On 28 June, the associated area of disturbed weather became better organized over the Bay of Campeche. A tropical depression formed later that day about 60 miles northeast of Veracruz, Mexico. The cyclone quickly strengthened into a tropical storm. Bret moved west-northwestward and made landfall on the coast of Mexico near Tuxpan early on 29 June with maximum winds of 40 mph in a very small area near the center. The system dissipated over the mountains of Mexico early on 30 June. Bret produced flooding in the Mexican state of Veracruz, where there was one confirmed death in the town of Cerro Azul.

Hurricane Cindy

Cindy formed from a tropical wave that left the coast of Africa on 24 June. The wave spawned a depression on 3 July in the Caribbean Sea just east of the Yucatan-Belize border. The cyclone moved northwestward across the northeastern Yucatan Peninsula before emerging over the south-central Gulf of Mexico on 4 July. Once over the warm Gulf waters, the depression strengthened into a tropical storm early on 5 July as the cyclone turned northward. Additional strengthening occurred, and Cindy became a hurricane with maximum sustained winds of 75 mph just before making landfall just southwest of Grand Isle, Louisiana early on 6 July. Cindy then turned northeastward, passing just east of New Orleans, Louisiana before making landfall on the Mississippi coast as a tropical storm later that day. The cyclone continued northeastward across the southeastern United States and merged with a frontal system over northern Georgia on 7 July. The extratropical remnants of Cindy moved northeastward along the Appalachian Mountains and across New England and southeastern Canada before dissipating over the Gulf of St. Lawrence on 11 July.

An automated platform run by Louisiana State University reported sustained winds of 77 mph with a gust to 86 mph at an elevation of 133 ft at 0100 UTC 6 July. Lakefront Airport in New Orleans reported sustained winds of 54 mph with a gust to 70 mph at 0800 UTC 6 July, while Pascagoula, Mississippi reported sustained winds of 46 mph with a gust to 55 mph at 1025 UTC that day.

Cindy and its extratropical remains caused heavy rainfall across much of the southeastern United States, with the maximum reported rainfall 8.01 inches at Galliano, Louisiana. Additionally, the cyclone caused 33 tornadoes over the southeastern United States, including a damaging F2 tornado near Hampton, Georgia.

Cindy caused one death in Georgia due to flooding. The storm caused $320 million in damage in the United States.

Hurricane Dennis

Hurricane Dennis formed form a tropical wave that moved westward from the coast of Africa on 29 June. A tropical depression developed on 4 July near the southern Windward Islands. The cyclone moved west-northwestward across the eastern and central Caribbean sea, became a tropical storm on 5 July, and strengthened into a hurricane early on 6 July about 245 miles east-southeast of Jamaica. Dennis intensified over the next 2 days and became a major hurricane on 7 July, and a strong category 4 hurricane with winds of 150 mph on

8 July just south of central Cuba. Dennis passed over Cabo Cruz, Cuba early on 8 July with winds of 135 mph, and then made landfall along the south-central coast of Cuba that afternoon near Cienfuegos with winds of 145 mph. After making landfall, Dennis passed very near Havana and weakened to a Category 1 hurricane before emerging over the southeastern Gulf of Mexico early on 9 July. Although Dennis re-intensified into a Category 4 hurricane with winds of 145 mph early on the 10 July over the eastern Gulf of Mexico, it weakened to Category 3 strength before making landfall over the western Florida Panhandle near Navarre Beach late on 10 July. Dennis weakened to a low pressure area over the Tennessee and Ohio valleys, and it was eventually absorbed by an extratropical low over southeastern Canada on 18 July.

Dennis brought hurricane conditions to portions of southeastern, central, and western Cuba. Cabo Cruz reported sustained winds of 133 mph with a gust to 148 mph at 0200 UTC 8 July, with a minimum pressure of 956 mb at 0240 UTC just before the eye passed over the station. The anemometer was destroyed, and it is possible more extreme winds occurred. Dennis also caused hurricane conditions in the western Florida Panhandle. An instrumented tower run by the Florida Coastal Monitoring Program (FCMP) at Navarre measured 1-min average winds (5-m elevation) of 99 mph and a gust to 121 mph at 1921 UTC 10 July.

Heavy rainfall occurred over much of Florida and extended well inland over portions of the southeastern United States with the maximum amount of 12.80 inches near Camden, Alabama. Ten tornadoes were also reported in association with Dennis.

Dennis caused 42 deaths - 22 in Haiti, 16 in Cuba, 3 in the United States, and 1 in Jamaica. The hurricane caused considerable damage occurred across central and eastern Cuba as well as the western Florida Panhandle, including widespread utility and communications outages. Considerable storm surge-related damage also occurred near St. Marks, Florida, well east of the landfall location. The damage associated with Dennis in the United States is estimated at $2.23 billion. Damage in Jamaica is estimated at 1.9 billion Jamaican dollars (approximately $31.7 million U. S. dollars).

Hurricane Emily

Emily formed from a tropical wave that moved westward from the coast of Africa on 6 July. The system spawned a tropical depression on 11 July about 1235 miles east of the southern Windward Islands. Moving westward, the depression became a tropical storm the following day. Emily became a hurricane early on 14 July just a few hours before the center crossed Grenada. Later that day Emily reached major hurricane strength over the eastern Caribbean sea. Over the next few days it moved west-northwestward across the Caribbean, reaching a peak intensity of 160 mph (the earliest Category 5 hurricane of record) on 17 July when it was south of Hispaniola. Emily passed south of Jamaica and the Cayman Islands, and then struck the Yucatan Peninsula near Tulum on 18 July with maximum winds near 135 mph (Category 4). Emily weakened while crossing Yucatan, but became a major hurricane again in the southwestern Gulf of Mexico on 19 July. Emily made its final landfall the next day near San Fernando, Mexico, with maximum winds near 125 mph (Category 3). The cyclone then weakened and dissipated on 21 July over northern Mexico.

Emily brought hurricane conditions to Grenada, the northeastern Yucatan, and portions of northeastern Mexico. The cyclone also caused tropical storm conditions in south Texas. Emily was responsible for six deaths - one in Grenada and five in Jamaica. It caused notable property damage on Grenada, in the northeastern Yucatan Peninsula, and in northeastern Mexico.

Tropical Storm Franklin

Franklin formed from a tropical wave that emerged from the coast of Africa on 10 July. It became a tropical depression on 21 July near the central Bahamas and a tropical storm late that day. Franklin turned northward and then northeastward during the next two days while strengthening to its peak intensity of 70 mph on 23 July. During 23-26 July, Franklin moved erratically east-northeastward in the general direction of Bermuda, with winds weakening to 40 mph by 25 July due to northwesterly wind shear. Franklin passed about 200 miles west of Bermuda on 26 July. Franklin then moved slowly northward on 27-28 July while it re-intensified to 60 mph. On 28 July, a frontal system moved off the east coast of the United States and accelerated Franklin northeastward. Franklin weakened after passing north of the gulf stream early on 29 July, became extratropical late on 29 July, and merged with a frontal zone while passing south of Newfoundland on 30-31 July.

There are no reports of casualties or damages due to Franklin, and the associated tropical storm-force winds stayed east of the Bahamas.

Tropical Storm Gert

Gert formed from a tropical wave that moved westward from the coast of Africa on 10 July. The system developed into a tropical depression in the Bay of Campeche on 23 July, and it strengthened to a tropical storm later that day while moving slowly west-northwestward. Gert made landfall just north of Cabo Rojo, Mexico late on 24 July with 45-mph winds. The storm dissipated over central Mexico on 25 July. The cyclone brought locally heavy rainfall to areas that had been affected by Hurricane Emily less than a week earlier, but there are no reports of casualties or damages from Gert.

Tropical Storm Harvey

Harvey formed from a tropical wave that exited the coast of Africa on 22 July. This wave showed signs of organization as it moved westward across the tropical Atlantic for several days before reaching the northeastern Caribbean sea on 29 July. An associated area of disturbed weather crossed Hispaniola on 30 July and moved northward for a couple of days. The system organized into a tropical depression on 2 August about 370 miles southwest of Bermuda. Moving northward, the cyclone strengthened into Tropical Storm Harvey on 3 August. The next day, Harvey turned toward the east-northeast and reached its peak intensity of 65 mph. The storm drifted northward on 6 August, then turned northeastward the next day in response to an upper-level trough approaching from the west. Harvey became a large and powerful extratropical cyclone late on 8 August about 565 miles southeast of Cape Race, Newfoundland. The system lingered over the north Atlantic for several days before finally losing its identity on 14 August.

Bermuda reported sustained winds of 37 mph with a gust to 51 mph as Harvey passed about 45 miles to the south on 4 August. There are no reports of damage or casualties due to Harvey.

Hurricane Irene

Irene formed from a tropical wave that moved off the coast of Africa on 1 August. It developed into a depression on 4 August about 690 miles southwest of the Cape Verde Islands, but promptly turned northwestward across cooler waters. This halted further development until 7 August, when the depression strengthened to a tropical storm about 1250 miles east of the northern Leeward Islands. Irene moved over the open waters of the central tropical Atlantic for the next few days, weakening to a tropical depression before re-strengthening to a tropical storm on 11 August. Irene turned northwestward and passed between Bermuda and Cape Hatteras, North Carolina on 14 August. The cyclone turned north-northeastward and strengthened into a hurricane, reaching its peak intensity of 105 mph on 16 August. The hurricane turned eastward and weakened. Irene then moved east-northeastward over much cooler waters and was absorbed by an extratropical low about 290 miles east-southeast of Cape Race on 18 August.

There are no reports of damage or casualties due to Irene.

Tropical Storm Jose

Jose was a short-lived tropical storm that formed from a tropical wave that moved westward from the coast of Africa on 8 August. The wave spawned a tropical depression on 22 August over the Bay of Campeche about 110 miles east of Veracruz, with the depression becoming a tropical storm later that day. Maximum winds reached 60 mph as Jose made landfall early on 23 August about 35 miles north of Veracruz. Shortly thereafter, the cyclone dissipated over the mountains of eastern Mexico. Jose produced locally heavy rains over portions of eastern Mexico, which resulted in mudslides that caused six deaths.

Hurricane Katrina

Katrina will be recorded as the most devastating hurricane to date in the history of the United States. It produced catastrophic damage and casualties in the New Orleans area and along the Mississippi coast, as well as additional casualties in south Florida. Katrina was directly responsible for an estimated 1200 deaths in the U. S., making it the deadliest U. S. hurricane since the Palm Beach-Lake Okeechobee hurricane of September 1928. Katrina also caused an estimated $75 billion dollars in damage, making it the costliest U. S. hurricane on record.

This horrific tropical cyclone formed from the combination of a tropical wave, an upper-level trough, and the mid-level remnants of Tropical Depression Ten. A tropical depression formed on 23 August about 200 miles southeast of Nassau in the Bahamas. Moving northwestward, it became a tropical storm the following day about 75 miles east-southeast of Nassau. Katrina moved through the northwestern Bahamas, and then turned westward toward south Florida while gradually strengthening. Katrina became a hurricane just before making landfall near the Miami-Dade/Broward county line during the evening of 25 August. Katrina moved southwestward across south Florida and into the eastern Gulf of Mexico on 26 August. Katrina then strengthened significantly, reaching Category 5 intensity on 28 August. Later that day, Katrina's winds reached a peak intensity of 175 mph with an aircraft-measured central pressure of 902 mb when centered about 195 miles southeast of the mouth of the Mississippi River. Katrina turned to the northwest and then north, making landfall near Buras, Louisiana at 1110 UTC 29 August with maximum winds estimated at 125 mph (Category 3). Continuing northward, Katrina made a second landfall near the Louisiana/Mississippi border at 1445 UTC with maximum winds estimated at 120 mph (Category 3). Katrina weakened as it moved inland to the north-northeast but was still a hurricane well inland near Laurel, Mississippi. Katrina continued to weaken and became a tropical depression over the Tennessee Valley on 30 August. The cyclone became an extratropical low on 31 August and was absorbed by a frontal zone later that day over the eastern Great Lakes.

Katrina brought hurricane conditions to large portions of southeastern Louisiana, southern Mississippi, and southwestern Alabama. The Coastal Marine Automated Network (C-MAN) station at Grand Isle, Louisiana reported 10-minute average winds of 87 mph at 0820 UTC 29 August with a gust to 114 mph. Higher winds likely occurred, as many stations were destroyed or lost power and communications during the storm. Hurricane conditions also occurred over south Florida. The National Hurricane Center reported sustained winds of 69 mph at 0115 UTC 26 August with a gust to 87 mph. Additionally, tropical storm conditions occurred along the northern Gulf coast as far east as the coast of the western Florida Panhandle, as well as in the Florida Keys.

Katrina is responsible for approximately 1200 deaths, including 1000 in Louisiana and 200 in Mississippi. Seven additional deaths occurred in southern Florida. Katrina caused catastrophic damage in southeastern Louisiana and southern Mississippi. Storm surge along the Mississippi coast caused total destruction of many structures, with the surge damage extending several miles inland. Similar damage occurred in portions of southeastern Louisiana southeast of New Orleans. The surge overtopped and ruptured levees in the New Orleans metropolitan area, resulting in the inundation of much of the city and its eastern suburbs. Wind damage from Katrina extended well inland into northern Mississippi and Alabama. Katrina's track across south Florida, resulting in over a foot of rain, toppled trees and power lines, and damaged homes and businesses in Miami-Dade and Broward counties.

Tropical Storm Lee

Tropical Storm Lee developed from a tropical wave that moved westward from Africa on 24 August. It first became a depression on 28 August about midway between Africa and the Lesser Antilles. The depression dissipated the following day, but its remnants redeveloped into a depression and then an estimated 40-mph tropical storm on 31 August. The system then weakened, becoming a remnant low pressure area on 2 September several hundred miles northeast of Bermuda. The low was absorbed by a cold front late on 3 September. There are no reports of damage or casualties from Lee.

Hurricane Maria

Maria developed from a vigorous tropical wave that crossed the west coast of Africa on 27 August. The system became a tropical depression on 1 September while centered about 1045 miles east of the northern Leeward Islands. Moving west-northwestward to northwestward, the cyclone strengthened into a tropical storm the next day. Maria turned north-northwestward and became a hurricane on 4 September. It reached an estimated peak intensity of 115 mph early on 6 September when the cyclone was centered about 475 miles east of Bermuda. Over the next few days, Maria recurved northeastward while the intensity slowly decreased, with the cyclone weakening to a tropical storm early on 9 September. Maria became a powerful extratropical storm over the north Atlantic about 760 miles east of Cape Race on 10 September. The storm moved past Iceland on 13 September and merged with another extratropical low the next day. This combined low caused a landslide and 1 death in Norway.

Hurricane Nate

Hurricane Nate formed from a tropical wave that exited the coast of Africa on 30 August. The northern portion of the wave broke away and moved northwestward as it interacted with a weak upper-level trough near Bermuda. A tropical depression formed late on 5 September about 350 miles south-southwest of Bermuda, and the system strengthened into a tropical storm just 6 hours later. Nate drifted northeastward for the next 2 days and intensified into a hurricane by 7 September about 260 miles south-southwest of Bermuda. Early on 8 September, Nate accelerated east-northeastward and passed about 125 miles southeast of Bermuda. The cyclone weakened back to a tropical storm on 9 September. Slow weakening continued as upper-level shear increased ahead of an approaching frontal system, and Nate transformed into an extratropical low pressure system on 10 September about 805 miles west of the Azores. The extratropical remnants of Nate continued quickly east-northeastward, eventually being absorbed by a larger extratropical system late on 12 September.

Bermuda reported a gust to 48 mph at 1525 UTC 10 September. There are no reports of damage or casualties due to Nate.

Hurricane Ophelia

Erratic Hurricane Ophelia formed from an area of disturbed weather at the western end of an old frontal system. The cyclone began organizing on 4 September over the central and northwestern Bahamas, and a tropical depression formed on 6 September near Grand Bahama Island. The depression moved erratically north-northwestward and became Tropical Storm Ophelia on 7 September. Ophelia meandered off the central Florida coast for the next two days, briefly becoming a hurricane on 8 September. Ophelia moved northeastward late on 9 September, and this continued until it again stalled on 11 September about 235 miles south of Cape Hatteras, North Carolina. During that time, it twice reached hurricane strength before weakening back to a tropical storm. Ophelia made a slow loop on 12-13 September, moving southwestward and northwestward before beginning a northward motion toward the North Carolina coast. The cyclone became a hurricane yet again late on 13 September, and maximum sustained winds reached 85 mph by the time the northern eyewall reached the North Carolina coast near Cape Fear on 14 September. Ophelia turned slowly east-northeastward with the center passing south of Cape Lookout and Cape Hatteras on 15 September. It then weakened to a tropical storm early on 16 September about 45 miles south-southeast of Cape Hatteras. Ophelia accelerated northeastward later on 16 September and passed east of Cape Cod the next day. The storm became an extratropical low near Nova Scotia early on 18 September, passed over Newfoundland on 19 September, and reached the eastern Atlantic on 21 September. The extratropical remnants of Ophelia dissipated over the North Sea on 23 September.

Ophelia brought hurricane conditions to portions of the North Carolina coast. The strongest reported winds were from the C-MAN station at Cape Lookout, which reported 2-minute average winds of 75 mph at 2309 UTC 14 September with a gust to 92 mph. The National Ocean Service (NOS) station at Wrightsville Beach reported 6-minute average winds of 68 mph at 1700 UTC 14 September with a gust of 79 mph. Ophelia also brought tropical storm conditions along portions of the east coast of Florida.

One death was attributed to Ophelia - a drowning along the southeastern coast of Florida. The storm caused an estimated $70 million in the United States, with significant beach erosion noted from the North Carolina coast southward to the central Florida coast.

Hurricane Philippe

Philippe formed from a tropical wave which moved westward from Africa on 9 September. A tropical depression formed from the wave on 17 September about 330 miles east of Barbados, and became a tropical storm later that day. Philippe moved north-northeastward to the east of the Lesser Antilles and strengthened, becoming a hurricane on 19 September about 360 miles east of the northern Leeward Islands. Philippe reached its peak intensity of 80 mph early the following day. Continuing to the north-northwest over open waters, Philippe weakened to a tropical storm on 20 September as vertical wind shear increased. The cyclone turned northward on 21 September while becoming embedded within a larger non-tropical area of low pressure. Rotating counter-clockwise within the larger low, Philippe turned westward and southward during the ensuing 48 hours as it weakened to a tropical depression. The circulation of Philippe was absorbed by the non-tropical low early on 24 September. There are no reports of damage or casualties due to Philippe.

Hurricane Rita

Rita was an intense, destructive, and deadly hurricane that significantly impacted the Florida Keys and devastated portions of southeastern Texas and southern Louisiana. Rita became a depression just east of the Turks and Caicos Islands late on 17 September. It moved westward and became a tropical storm the following afternoon. Maximum winds increased to 70 mph as Rita moved the central Bahamas on 19 September. While the storm did not strengthen during the following night, rapid intensification began on 20 September as it moved through the Straits of Florida. Rita reached Category 2 intensity as the center passed about 50 miles south of Key West, Florida.

After entering the Gulf of Mexico, Rita intensified from Category 2 to Category 5 in about 24 hours. The maximum sustained winds reached 165 mph on the afternoon of 21 September, and the hurricane reached a peak intensity of 180 mph early on 22 September. Rita began to weaken later that day and continued a slow weakening trend until landfall. Rita turned northwestward on 23 September. It made landfall around 0830 UTC 24 September just east of the Texas/Louisiana border between Sabine Pass and Johnson's Bayou with 120 mph winds (Category 3). It weakened after moving inland, but remained a tropical storm until reaching northwestern Louisiana late on 24 September. It then turned northeastward and merged with a frontal system two days later.

Rita brought hurricane conditions to southwestern Louisiana and southeastern Texas. A FCMP instrumented tower at Port Arthur reported 1-min average winds of 94 mph at 0826 UTC 24 September along with a gust of 116 mph. The C-MAN station at Sea Rim State Park, Texas reported 2-minute average winds of 82 mph at 0700 UTC 24 September, along with a peak gust of 99 mph. The storm also brought tropical storm conditions to the Florida Keys, where the C-MAN station at Sand Key reported 10-minute average winds of 72 mph at 2110 UTC 20 September with a gust to 92 mph. The station failed shortly thereafter.

Rita caused devastating storm surge flooding and wind damage in southwestern Louisiana and extreme southeastern Texas, including a surge on Lake Livingston, Texas. Although the center did not make landfall in the Florida Keys, it downed trees and produced storm tides of up to five feet in portions of the island chain, flooding sections of U. S. Highway 1 and many other streets. Also, while the center passed well west of New Orleans, it produced a storm surge that inundated portions of the New Orleans area previously flooded by Katrina. Rita caused seven deaths and damage estimated at $10 billion in the United States.

Hurricane Stan

Stan developed from a tropical wave that moved westward from the coast of Africa on 17 September. The wave generated a persistent area of disturbed weather over the western Caribbean Sea in late September. A tropical depression eventually formed on 1 October about 130 miles southeast of Cozumel. The cyclone moved west-northwestward, attaining tropical storm status just before crossing the east coast of the Yucatan Peninsula just south of Tulum, Mexico on 2 October. Stan traversed the Yucatan and weakened to a depression, but it regained tropical storm strength after moving into the Bay of Campeche on 3 October. The storm turned from a westward to a southwestward heading and continued to strengthen, becoming a hurricane early on 4 October. A few hours later, Stan made landfall about 90 miles east-southeast of Veracruz with maximum winds estimated at 80 mph. The cyclone weakened rapidly after moving inland and dissipated over the mountains of southern Mexico on 5 October.

During Stan's life, a larger area of disturbed weather caused torrential rains with severe flash floods and mud slides over portions of Mexico and Central America, including Guatemala, El Salvador, Nicaragua, Honduras, and Costa Rica. The estimated death toll associated with this weather system ranges from 1000-2000. As best as can be determined, Stan itself was responsible for 80 of these deaths.

Tropical Storm Tammy

Tammy was a short-lived tropical storm that developed from a complex interaction between a tropical wave that left Africa on 24 September and an upper-level trough. Early on 5 October, this combination quickly produced a tropical storm about 25 miles east of Jupiter, Florida. The cyclone moved steadily north-northwestward parallel to the Florida east coast most of the day. Late that day, it turned northwestward and made landfall along the northeastern Florida coast near Atlantic Beach with maximum sustained winds of 50 mph. Tammy moved westward over southern Georgia and southeastern Alabama on 6 October before becoming absorbed by a larger extratropical low pressure system over the Florida Panhandle the next day.

Tammy brought tropical storm conditions to portions of the southeastern coast of the United States. The NOS station at Fort Pulaski, Georgia reported 6-minute average winds of 44 mph at 0200 UTC 6 October with a peak gust of 52 mph. The C-MAN station at Folly Beach, South Carolina reported 10-minute average winds of 40 mph at 2030 UTC 5 October with a peak gust of 55 mph. There were no reports of casualties and damage was minor.

Hurricane Vince

Vince, the first known tropical cyclone to make landfall in Spain, developed from a non-tropical area of low pressure. An occluded deep-layer frontal low moved southeastward across the Azores Islands on 6 October. Over the next couple of days, the frontal structure gradually dissipated and banded convection became more concentrated near the circulation center. It is estimated that the low became a subtropical storm near 0600 UTC 8 October when centered about 575 miles southeast of Lajes in the Azores. The cyclone gradually acquired tropical characteristics and became a tropical storm and then a hurricane on 9 October while it moved slowly northeastward to the northwest of the Madeira Islands. Increasing vertical wind shear caused Vince to weaken to a tropical storm the next day as it accelerated east-northeastward. On 11 October, Vince weakened to a tropical depression shortly before making landfall near Huelva, Spain. The cyclone dissipated later that day over Spain. There are no reports of damage or casualties due to Vince.

Hurricane Wilma

The large and powerful Wilma formed from a large area of disturbed weather that stretched across much of the Caribbean Sea during the second week of October. A surface low pressure system gradually became defined near Jamaica on 14 October, leading to the formation of a tropical depression on 15 October about 220 miles east-southeast of Grand Cayman. The cyclone moved erratically westward and southward for two days while slowly strengthening into a tropical storm. Wilma became a hurricane and began a west-northwestward motion on 18 October. Later that day, Wilma began to explosively deepen. The aircraft-measure minimum central pressure dropped 88 mb in 12 hours, reaching 882 mb near 0800 UTC 19 October. This is the lowest pressure of record for an Atlantic hurricane, and was accompanied by a 2-4 mile wide eye. Wilma's maximum intensity is estimated to have been 185 mph a few hours after the 882 mb pressure. On 20 October, Wilma weakened slightly and turned northwestward toward the northeastern Yucatan Peninsula. Late on 21 October, the slowly-moving hurricane made landfall over Cozumel, followed by landfall early the next day over the northeastern Yucatan Peninsula - both at Category 4 intensity. Wilma moved slowly and weakened over northeastern Yucatan, emerging over the Gulf of Mexico early on 23 October as a Category 2 hurricane. Later that day it accelerated northeastward toward southern Florida. The hurricane strengthened over the Gulf waters, and it made landfall near Cape Romano around 1030 UTC 24 October at Category 3 intensity. The system continued to accelerate northeastward, with the eye crossing Florida in less than 5 hours. Wilma moved into the Atlantic just to the north of Palm Beach as a Category 2 hurricane. It briefly re-intensified just off the east-central coast of Florida, then weakened thereafter. The hurricane moved rapidly northeastward over the western Atlantic and became extratropical about 230 miles southeast of Halifax, Nova Scotia late on 25 October. The extratropical remnants of Wilma were absorbed by another low late the next day.

Wilma brought hurricane conditions to the northeastern Yucatan Peninsula and the adjacent islands, as well as to southern Florida. In Mexico, Cancun reported 10-minute average winds of 100 mph with a gust to 130 mph at 0000 UTC 22 October, while Cozumel reported a pressure of 928.0 mb late on 21 October. The Isla Mujeres reported 62.05 inches of rain during the hurricane's passage. In Florida, a South Florida Water Management District (SFWMD) station in Lake Okeechobee reported 15-minute average winds of 92 mph with a gust to 112 mph at 1500 UTC 24 October, while a nearby SFWMD station in Belle Glade reported a gust to 117 mph.

Twenty-two deaths have been directly attributed to Wilma: 12 in Haiti, 1 in Jamaica, 4 in Mexico, and 5 in Florida. The hurricane caused severe damage in northeastern Yucatan, including Cancun and Cozumel, and widespread damage estimated at $16.8 billion in southern Florida. Wilma also produced major flooding over western Cuba.

Tropical Storm Alpha

For the first time, the National Hurricane Center had to use the Greek alphabet to name a tropical cyclone when the record-breaking Alpha formed. A vigorous tropical wave passed through the Windward Islands on 19 October. Shower activity became concentrated south of Puerto Rico, and radar data from the island helped determine that a tropical depression formed early on 22 October about 205 miles south-southwest of San Juan. The depression became Tropical Storm Alpha later that day. Alpha moved northwestward and made landfall near Barahona, Dominican Republic on 23 October with 50-mph winds. Alpha weakened to a tropical depression over the high terrain of Hispaniola, with the cyclone continuing northwestward and northward over the southeastern Bahamas and the Atlantic later that day. The system was absorbed by the much-larger Hurricane Wilma late on 24 October.

Barahona reported sustained winds of 50 mph as the center of Alpha passed nearby. Alpha caused 17 deaths in Haiti and 9 in the Dominican Republic, primarily from flooding caused by heavy rains.

Hurricane Beta

Beta developed over the extreme southwestern Caribbean Sea from a tropical wave. A surface low pressure system formed along the wave axis near the coast of Colombia on 25 October. The system became a tropical depression the next day about 170 miles east of the Costa Rica-Nicaragua border. The depression moved slowly northward for a couple of days, while becoming a tropical storm on 27 October. Beta strengthened into a hurricane on 29 October near Providencia Island. It then turned westward and west-southwestward on 30 October as it strengthened to an estimated peak intensity of 115 mph (Category 3). The hurricane then weakened slightly, making landfall as a Category 2 hurricane near La Barra on the east coast of Nicaragua. Beta moved westward and dissipated over western Nicaragua early on 31 October.

There are no reports of casualties from Beta. The storm caused widespread damage on Providencia Island. Extensive damage to structures was reported along the central Nicaraguan coast. Significant flooding also occurred in Honduras.

Tropical Storm Gamma

The vigorous tropical wave that spawned Gamma moved off the coast of Africa on 3 November. The wave passed through the southern Windward Islands on 13 November, producing wind gusts to near tropical storm-force along with heavy rainfall. Early on 14 November, a tropical depression formed over the Caribbean Sea about 100 miles west of St. Vincent. The cyclone moved westward and briefly became a tropical storm on 15 November. Thereafter, strong westerly upper-level shear caused degeneration back into a tropical wave. The wave accelerated westward across the central Caribbean Sea on 17 November before slowing down over the western Caribbean and eastern Honduras on 18 November. In the meantime, a large non-convective low pressure system developed over Panama, moved northwestward, and merged with the wave over central Honduras. This combination regenerated into Tropical Storm Gamma near the northern coast of Honduras late on 18 November. Gamma drifted northward over the northwestern Caribbean Sea and strengthened to its peak intensity of 50 mph while just east of Roatan Island on 19 November. It then turned slowly southeastward on 20-21 November while weakening due to northwesterly vertical wind shear. Gamma degenerated into a non-convective remnant low late on 21 November and dissipated the next day just east of the Nicaragua-Honduras border.

A private weather station on Roatan reported sustained winds of 50 mph at 0730 UTC 19 November. Heavy rainfall caused flash floods and mud slides in Honduras and Belize, which resulted in 37 deaths - 34 in Honduras and 3 in Belize. At least 13 people in Honduras were also missing. The rains and flooding also caused damage to crops and bridges.

Tropical Storm Delta

Delta originated from an extratropical low over the central Atlantic, beginning on 19 November about 1380 miles southwest of the Azores. The low moved eastward and then northeastward, reaching a position about 815 miles southwest of the Azores on 22 November. The low turned south-southwestward later that day and developed into a subtropical storm. Delta continued south-southwestward on 23 November as it became a tropical storm, and winds reached an estimated 70 mph the next day as the storm stalled about 1320 miles west-southwest of the Canary Islands. Delta moved southwestward on 25 November, then turned east-northeastward on 26 November. The storm weakened during this time, with estimated maximum winds decreasing to 40 mph by 26 November. Delta accelerated northeastward and re-intensified on 27 November, with maximum winds again reaching 70 mph. The cyclone turned eastward and became a vigorous extratropical low on 28 November about 245 miles west-northwest of the western Canary Islands. The extratropical low brought wind gusts of hurricane force to the Canary Islands later on 28 November before weakening and moving into Morocco on 29 November. The cyclone dissipated late that day over northwestern Algeria.

There are no reports of damage or casualties from Delta as a tropical or subtropical cyclone. However, the extratropical low caused seven deaths in or near the Canary Islands.

Hurricane Epsilon

Epsilon, like its predecessor Delta, had a non-tropical origin. A gale center formed about 1150 miles east of Bermuda on 27 November. The low developed central convection and transitioned into a tropical storm on 29 November. Epsilon tracked in a small cyclonic loop for the next few days as it gradually intensified. The cyclone moved northeastward and became a hurricane on 2 December about 980 miles east-northeast of Bermuda. The hurricane turned eastward on 3 December and continued this motion through 5 December. It reached an estimated peak intensity of 85 mph early on 5 December. Epsilon turned southwestward on 6 December and began weakening. It became a tropical storm on 7 December, followed by decay to a tropical depression and a non-convective remnant low the next day. Epsilon dissipated on 9 December about 1140 miles southwest of the Azores. There are no reports of damage or casualties due to Epsilon.

Tropical Storm Zeta

Zeta developed from a combination of a old frontal zone and an upper-level trough. A surface trough developed over the eastern tropical Atlantic on 28 December. A surface low pressure area formed on 29 December about 775 miles northwest of the Cape Verde Islands. The low became a tropical depression early on 30 December and a tropical storm later that day. Zeta moved slowly northwestward on 30 December, then drifted westward on 31 December and southwestward on 1 January. The storm reached an estimated peak intensity of 65 mph on 1 January, then weakened due to vertical shear. A faster, generally west-southwestward, motion began on 2 January and continued the next day. Some re-intensification occurred on 3 January, and Zeta again reached an estimated peak intensity of 65 mph. The storm turned westward on 4 January and west-northwestward the next day. Increasing vertical wind shear during this time caused weakening, and Zeta became a depression on 6 January. The depression became a non-convective low late that day, and it finally dissipated about 660 miles southeast of Bermuda on 7 January.

2005 Atlantic Tropical Storms and Hurricanes

Storm Name	Type*	Dates**	Max. Winds (mph)	Min. Pressure (mb)	Deaths	U. S. Damages ($million)
Arlene	T	8-13 June	70	989	1	Minor
Bret	T	28-30 June	40	1002	1	
Cindy	H	3-7 July	75	991	1	320
Dennis	H	4-13 July	150	930	42	2,230
Emily	H	11-21 July	160	929	6	Minor
Franklin	T	21-29 July	70	997		
Gert	T	23-25 July	45	1005		
Harvey	T	2-8 August	65	994		
Irene	H	4-18 August	105	970		
Jose	T	22-23 August	60	998	6	
Katrina	H	22-30 August	175	902	1200	75,000
Lee	T	28 Aug – 2 Sep	40	1006		
Maria	H	1-10 September	115	962		
Nate	H	5-10 September	90	979		
Ophelia	H	6-17 September	85	976	1	70
Philippe	H	17-24 September	80	985		

Storm Name	Type*	Dates**	Max. Winds (mph)	Min. Pressure (mb)	Deaths	U. S. Damages ($million)
Rita	H	18-26 September	180	895	7	10,000
Stan	H	1-5 October	80	977	80	
Tammy	T	5-6 October	50	1001		Minor
Vince	H	8-11 October	75	988		
Wilma	H	15-25 October	185	882	22	16,800
Alpha	T	22-24 October	50	998	26	
Beta	H	26-31 October	115	960		
Gamma	T	14-21 November	50	1002	37	
Delta	T	22-28 November	70	980		
Epsilon	H	29 Nov - 8 Dec	85	981		
Zeta	T	30 Dec – 6 Jan	65	994		

* T - tropical storm, maximum sustained winds 39-73 mph; H - hurricane, maximum sustained winds 74 mph or higher. ** Dates based on UTC time and include tropical depression stage.

Eastern North Pacific

Tropical cyclone activity in the eastern North Pacific basin in 2005 included 15 named tropical storms. Seven of the tropical storms became hurricanes and only one (Kenneth) became a major hurricane (category three or stronger on the Saffir-Simpson hurricane scale) in the basin. One of the hurricanes (Jova) reached major hurricane status after crossing into the central Pacific basin. As in 2004, the activity was below average in terms of the numbers of hurricanes and major hurricanes. The long-term seasonal averages are: 15 tropical storms, 9 hurricanes, and 4 major hurricanes. There was one additional depression in 205 that did not reach tropical storm intensity. None of the tropical storms or hurricanes made landfall. Adrian was the only cyclone to make landfall and it did so in Honduras as a weakening tropical depression.

Adrian, the first storm of the season, originated from the combination of a broad area of low pressure south of Acapulco, Mexico and a tropical wave that crossed central America and entered the eastern North Pacific on 15 May. A tropical depression formed on 17 May about 460 miles west-southwest of El Salvador, and it strengthened into a tropical storm early the next day. The storm moved generally toward the east-northeast and reached hurricane strength with a peak intensity of 80 mph on 19 May about 85 miles southwest of El Salvador. A post-storm analysis indicates that Adrian did not make landfall as a hurricane in El Salvador early on 20 May, as assessed operationally. Based on examination of satellite data and surface observations, including ship data obtained after the event, it has been determined that southwesterly wind shear caused Adrian to weaken just offshore. The post-analysis indicates that Adrian was a weakening tropical storm early on 20 May as it moved eastward just off the coast of El Salvador, and later that day, the cyclone entered the Gulfo de Fonseca, east of El Salvador, as a tropical depression. The depression then made landfall on the Pacific coast of Honduras during the evening of 20 May. Even though the center did not make landfall in El Salvador, reports from there indicate that heavy rainfall caused flooding and mud slides. One death is directly attributable to Adrian due to flooding in Nicaragua.

Beatriz developed from a tropical wave and became a tropical depression on 21 June about 275 miles south of Zihuatanejo, Mexico. The cyclone strengthened slowly as it moved west-northwestward well offshore the Mexican coast, and became a tropical storm on 22 June. It reached its peak intensity of 50 mph early on the 23rd but easterly wind shear halted development and Beatriz weakened to a depression over cooler water early on the 24th. The cyclone degenerated into a non-convective remnant low later that day about 280 miles south-southwest of Cabo San Lucas, Mexico, on the southern tip of Baja California. Beatriz dissipated two days later. No reports of damages or casualties due to Beatriz have been received.

Calvin developed from a tropical wave that crossed Central America around 21 June. The area of disturbed weather associated with the wave moved slowly westward to the south of eastern Mexico for a few days, with unsteady development. Finally on 26 June, a tropical depression formed about 325 miles south-southeast of Acapulco, Mexico, and became a tropical storm later that day. It reached its peak intensity of 50 mph on 27 June. Similar to Beatriz, the development trend was reversed by easterly wind shear. Calvin weakened to a depression on 28 June and degenerated into a remnant low that night. The remnant circulation continued toward the west-northwest while producing intermittent deep but disorganized convection through 2 July. The low then turned westward, eventually dissipating on 3 July about 700 miles west-southwest of Cabo San Lucas.

Dora formed on 4 July about 145 miles south of Acapulco and became a tropical storm later on that day. Dora moved northwestward and came within 40 miles of the Mexican coast near Zihuatanejo with a peak intensity of 45 mph, but then turned west-northwestward paralleling the coastline on 5 July. Dora moved away from Mexico on 6 July and weakened to a depression. It became a remnant low over cooler waters and quickly dissipated about 255 miles west of Manzanillo, Mexico later on the 6th.

Eugene formed from a tropical wave on 18 July about 255 miles south of Manzanillo. The cyclone moved generally northwestward parallel to the coast of Mexico for about a day, and reached its peak intensity of 70 mph about 200miles west-southwest of Cabo Corrientes on southwestern coast of Mexico. Eugene soon weakened to a tropical depression over cooler waters and it was reduced to a remnant low about 115 miles southwest of Cabo San Lucas late on 20 July. The remnant low continued northwestward and dissipated by 22 July.

Fernanda formed about 660 miles south-southwest of Cabo San Lucas on 9 August and became a tropical storm on the 10^{th} as it moved toward the west-northwest. Fernanda became a hurricane on 11 August and reached its peak intensity of 85 mph the next day before moving toward cooler waters and a hostile upper-level wind environment. Thereafter, Fernanda moved toward the west-southwest and gradually weakened. It dissipated on 17 August.

Greg formed as a tropical depression about 690 miles south of Cabo San Lucas on 11 August, and it became a tropical storm later that day. Greg moved slowly to the west-northwest and reached its peak intensity of 50 mph on 12 August. A developing ridge between Greg and Fernanda forced Greg to drift to the south and southwest while northerly shear weakened the cyclone. Greg weakened to a depression on 14 August and then degenerated into a remnant low the following day about 750 miles south-southwest of Cabo San Lucas.

Hilary developed into a tropical depression about 215 miles south of Salina Cruz, Mexico on 19 August. The cyclone moved westward and became a tropical storm the next day. For the next couple of days, Hilary took a path roughly parallel to the Mexican coast about 260 miles offshore. It became a hurricane early on 21 August, and as its wind field expanded, tropical storm force winds reached the coast of Mexico near Manzanillo later that day. Hilary edged away from the mainland and strengthened, reaching a peak intensity of 105 mph on 22 August. A slow weakening trend ensued as Hilary moved west-northwest to northwestward over cooler waters. The cyclone weakened to a tropical storm on 24 August about 500 miles west of Cabo San Lucas, and to a depression, and a non-convective remnant low the following day.

Irwin likely originated from the southern portion of the tropical wave that spawned powerful Atlantic Hurricane Katrina. It formed as a depression on 25 August about 155 miles south of Manzanillo. The depression moved westward and became a tropical storm early on 26 August, reaching a peak intensity of 50 mph later that day. The cyclone slowly weakened and became a depression early on 28 August, and to a remnant low later that day while centered about 565 miles southwest of Cabo San Lucas. The remnant low persisted until 3 September.

Jova was a long-track hurricane that crossed into the central Pacific basin and briefly threatened the Hawaiian Islands. Jova formed early on 12 September about 635 miles south-southwest of Cabo San Lucas. However, upper-level winds hindered development and Jova did not reach tropical storm status until early on 15 September about 1325 miles west-southwest of Cabo San Lucas. Jova continued on a track slightly south of due west for the next 2 days and gradually strengthened into a hurricane with 85 mph winds. Early on 18 September, Jova made an abrupt turn to the northwest and crossed 140°W longitude into the Central Pacific. Jova slowly intensified becoming a major hurricane on 20 September. Jova maintained category 3 or major hurricane status for the next 2 days. However, the hurricane moved over cooler waters, and slow weakening began early on 22 September when Jova was located about 470 miles east of the Hawaiian Islands. Jova weakened to a tropical storm early on 23 September as increasing southwesterly vertical wind shear enhanced the weakening process. Jova became a tropical depression early on 25 September and degenerated into a remnant low pressure system shortly thereafter. The cyclone dissipated later that day about 255 miles northeast of Honolulu, Hawaii. no reports of damages or casualties due to Jova have been received.

Kenneth developed on 14 September about 910 miles southwest of Cabo San Lucas, and it became a tropical storm the following day. Kenneth moved west-northwestward and intensified into a hurricane on 16 September. The hurricane continued to strengthen and developed a well-defined eye, reaching its peak intensity of 135 mph on 18 September. Kenneth moved slowly and gradually weakened to below hurricane strength on 20 September. The cyclone regained hurricane status on 25 September and drifted southwestward across 140°W longitude and into the central pacific hurricane basin on 26 September. Shortly thereafter, the cyclone weakened below hurricane strength and turned northwestward. The cyclone continued to weaken and became a tropical depression on 29 September about 390 miles east of the big island of Hawaii, and dissipated just east of the Big Island on 30 September. The remnants of Kenneth passed south of the Hawaiian islands producing some locally heavy rains.

Lidia was a short-lived tropical cyclone. It became a depression early on 17 September about 770 miles southwest of Cabo San Lucas and reached tropical storm status later that day. Lidia moved very little and on 18 September, it became absorbed by the much larger circulation of the tropical storm that eventually became Hurricane Max, located about 230 miles to the east.

Max formed as a tropical depression on 18 September about 575 miles south-southwest of Cabo San Lucas and it became a tropical storm later that day. As it moved west-northwestward, Max absorbed the smaller circulation of Lidia. Max then turned toward the northwest and strengthened on 19 September, and reached hurricane intensity early on 20 September. Max turned westward and reached its peak intensity of 80 mph later that day, but then began to weaken as it reached cooler waters. Max gradually weakened and became a tropical depression on 22 September and degenerated into a remnant low later on 22 September about 805 miles west of Cabo San Lucas.

Norma developed from a large tropical disturbance that lingered a few hundred miles south of Manzanillo for several days. A tropical depression formed early on 23 September and it strengthened into a tropical storm later that day. Moving slowly to the west-northwest, Norma gradually developed despite modest northeasterly shear and reached its peak intensity of 60 mph on 24 September. The vertical shear increased and gradually caused Norma to weaken and it became a tropical depression early on 27 September. Deep convection faded as Norma moved over cooler waters, and the cyclone degenerated to a remnant low later that day.

Otis formed from a tropical wave that moved westward from the coast of Africa on 9 September and may have spawned Atlantic Hurricane Philippe. The wave reached the eastern Pacific on 22 September and began to show signs of organization on 27 September. A tropical depression formed the next day about 140 miles south of Manzanillo. The cyclone moved westward and became tropical storm Otis on 29 September. Otis turned northwestward and achieved hurricane status on 30 September, reaching an estimated peak intensity of 105 mph on 1 October. It then weakened to a tropical storm the next day due to a combination of cool sea-surface temperatures and dry air. Otis became a depression on 3 October and degenerated into a non-convective remnant low pressure area on 4 October about 90 miles northwest of Cabo San Lazaro, Mexico. Otis brought tropical storm conditions and locally heavy rains to the mountainous areas of southern Baja California.

Tropical Depression Sixteen-E was a relatively long-lived tropical cyclone. It developed from an area of disturbed weather early on 15 October about 415 miles south of Acapulco. The depression moved westward to west-southwestward for the next 5 days, and at times the depression seemed as though it was about to become a tropical storm. However, unfavorable upper-level winds never allowed the strongest convection to remain near the low-level center for more than a few hours at a time. The depression eventually degenerated into a non-convective remnant low pressure system about 945 miles southwest of Cabo San Lucas late on 20 October. The remnant circulation was absorbed into another disturbance in the Intertropical Convergence Zone the next day.

2005 Eastern Pacific Tropical Storms and Hurricanes

Storm Name	Type*	Dates**	Max. Winds (mph)	Min. Pressure (mb)	Deaths
Adrian		17-21 May	80	982	1
Beatriz		21-24 June	50	1000	
Calvin		26-29 June	50	1000	
Dora		4-6 July	45	1003	
Eugene		18-20 July	70	989	
Fernanda		9-16 Aug	85	978	
Greg		11-15 August	50	1000	
Hilary		19-25August	105	970	
Irwin		25-28 August	50	1000	
Jova		12-25 September	85[a]	973	
Kenneth		14-30 September	135	948	
Lidia		17-19 September	40	1005	
Max		18-22 September	80	987	
Norma		23-27 September	60	997	
Otis		28 Sep-3Oct	105	970	

*T - tropical storm, maximum sustained winds 39-73 mph; H - hurricane, maximum sustained winds 74 mph or higher. ** Dates based on UTC time and include tropical depression stage.
[a] Jova reached 125 mph in the Central Pacific.

NATIONAL HURRICANE CENTER

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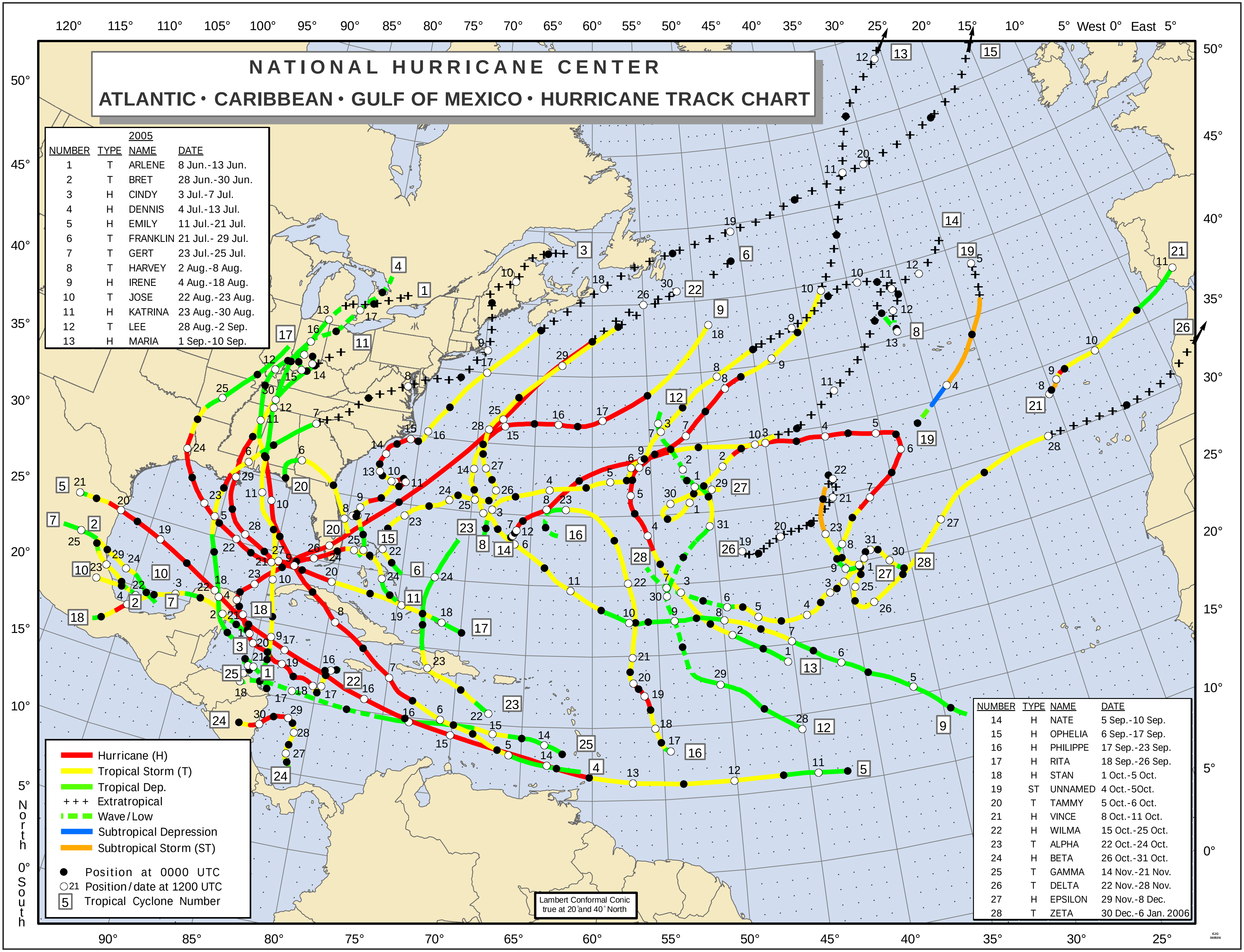
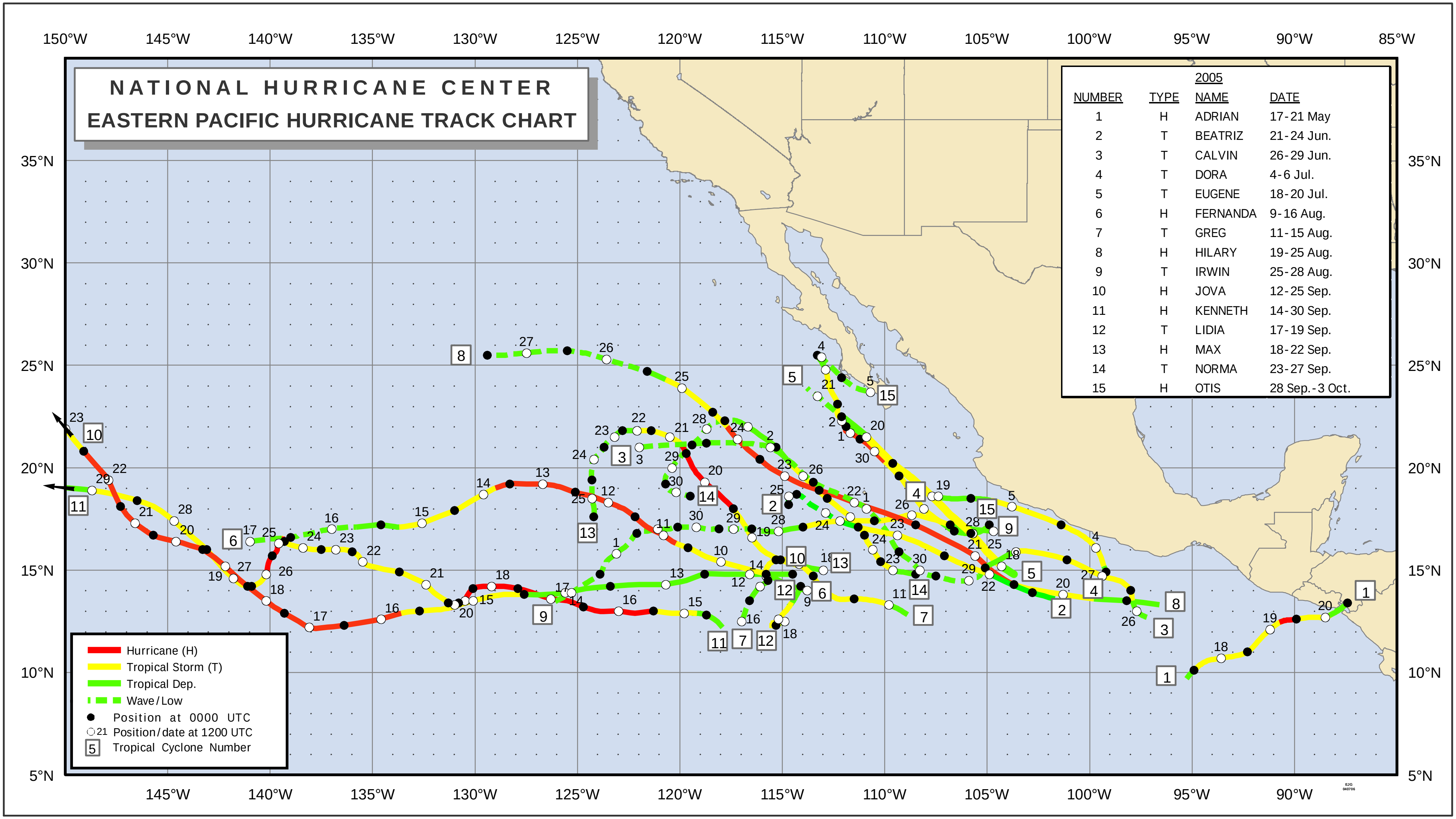


2005

NUMBER	TYPE	NAME	DATE
1	T	ARLENE	8 Jun.-13 Jun.
2	T	BRET	28 Jun.-30 Jun.
3	H	CINDY	3 Jul.-7 Jul.
4	H	DENNIS	4 Jul.-13 Jul.
5	H	EMILY	11 Jul.-21 Jul.
6	T	FRANKLIN	21 Jul.- 29 Jul.
7	T	GERT	23 Jul.-25 Jul.
8	T	HARVEY	2 Aug.-8 Aug.
9	H	IRENE	4 Aug.-18 Aug.
10	T	JOSE	22 Aug.-23 Aug.
11	H	KATRINA	23 Aug.-30 Aug.
12	T	LEE	28 Aug.-2 Sep.
13	H	MARIA	1 Sep.-10 Sep.

NUMBER	TYPE	NAME	DATE
14	H	NATE	5 Sep.-10 Sep.
15	H	OPHELIA	6 Sep.-17 Sep.
16	H	PHILIPPE	17 Sep.-23 Sep.
17	H	RITA	18 Sep.-26 Sep.
18	H	STAN	1 Oct.-5 Oct.
19	ST	UNNAMED	4 Oct.-5Oct.
20	T	TAMMY	5 Oct.-6 Oct.
21	H	VINCE	8 Oct.-11 Oct.
22	H	WILMA	15 Oct.-25 Oct.
23	T	ALPHA	22 Oct.-24 Oct.
24	H	BETA	26 Oct.-31 Oct.
25	T	GAMMA	14 Nov.-21 Nov.
26	T	DELTA	22 Nov.-28 Nov.
27	H	EPSILON	29 Nov.-8 Dec.
28	T	ZETA	30 Dec.-6 Jan. 2006


NATIONAL HURRICANE CENTER
EASTERN PACIFIC HURRICANE TRACK CHART
2005
NUMBER TYPE NAME DATE
1 H ADRIAN 17-21 May
2 T BEATRIZ 21-24 Jun.
3 T CALVIN 26-29 Jun.
4 T DORA 4-6 Jul.
5 T EUGENE 18-20 Jul.
6 H FERNANDA 9-16 Aug.
7 T GREG 11-15 Aug.
8 H HILARY 19-25 Aug.
9 T IRWIN 25-28 Aug.
10 H JOVA 12-25 Sep.
11 H KENNETH 14-30 Sep.
12 T LIDIA 17-19 Sep.
13 H MAX 18-22 Sep.
14 T NORMA 23-27 Sep.
15 H OTIS 28 Sep.-3 Oct.
Hurricane (H)
Tropical Storm (T)
Tropical Dep.
Wave/Low
Position at 0000 UTC
21 Position/date at 1200 UTC
5 Tropical Cyclone Number
150°W 145°W 140°W 135°W 130°W 125°W 120°W 115°W 110°W 105°W 100°W 95°W 90°W 85°W
35°N 30°N 25°N 20°N 15°N 10°N 5°N

APPENDIX VI

2005 HURRICANE SEASON REPORTS

(Submitted by Members of the RA IV Hurricane Committee)

ANTIGUA AND BARBUDA

The “normal” Hurricane Season generates nine (9) Tropical Storms, six (6) of which would develop into Hurricanes and of those six Hurricanes, two (2) would develop further into intense hurricanes, i.e. category 3, 4, 5 (Gray et al).

The year 2005 was a record-breaking year with an unsurpassed twenty-five (25) storms (up to November 24), thirteen (13) of which developed into hurricanes and of those thirteen hurricanes, seven (7) developed further into intense hurricanes.

Antigua and Barbuda and the Leeward Islands were once again fortunate not to be affected by any Tropical Storms or Hurricanes during 2005.

It should be noted, however, that a number of the Tropical Depressions and Tropical Storms which developed over the Caribbean Sea and the Gulf of Mexico had their genesis from Tropical Waves which passed over the islands producing substantial, above-average rainfall as they (tropical waves) moved towards the west.

Monthly rainfall recorded at V.C. Bird International Airport:

2005			45 year average (1960-2004)		
June -	8.81	inches	June	2.05	inches
July -	6.47	“	July	3.37	“
August -	4.57	“	August	3.78	“
September -	3.84	“	September	5.14	“
October -	7.91	“	October	5.14	“

Tropical Storm force gusts were also recorded during the passage of the tropical wave which spawned tropical storm Alpha.

These storm force gusts produced minor damage to shrubs and brittle plants such as pawpaw trees and banana trees.

Two episodes of Tornado activity were also recorded during the year 2005.

The first episode which was recorded during the month of April (out of season) is well documented and can be viewed on Antigua’s web site www.antiguamet.gov.ag. Two houses were damaged during this April tornado.

The second tornado episode which was recorded during the month of October also resulted in minor property damage.

Coordination between Antigua and the Leeward Islands and Antigua and the British Virgin Islands went smoothly this year.

BAHAMAS

The 2005 Hurricane Season was a record-breaking one that saw 26 tropical cyclones and two depressions traverse the waters of the Atlantic, Gulf of Mexico and the Western Caribbean Sea. The season marked the first time that meteorologists had to resort to the use of the Greek alphabet for the naming of tropical cyclones. Five of the tropical cyclones, namely, Franklin, Katrina, Ophelia, Rita and Wilma, affected the Bahamian archipelago. The impacts of the first four were minimal with the systems generating fresh breezes to islands that they traversed. Hurricane Wilma, on the other hand, wreaked havoc on the nation's second largest city Freeport, in Grand Bahama.

Hurricane Wilma developed from a tropical depression that formed about 195 miles southeast of Grand Cayman at 5 pm EDT on Saturday, 15 October. Over the next few days the system moved slowly between a west and northwest direction in the Western Caribbean Sea before becoming the 12th Hurricane of the season on Tuesday, 18th October at 11 a.m. Wilma struck Cozumel, Mexico and Honduras before making a turn to the northeast and accelerating towards Florida on Sunday, 23rd October.

On Monday, 24th October, while moving to the northeast near 25 miles per hour and passing with 60 nautical miles northwest of Freeport, Grand Bahama, tropical storm force winds (sustained 39-73 miles per hour) were experienced by residents in Grand Bahama from 7:00 a.m. through 8:00 p.m. However, during the period 11:00 a.m. to 2:00 p.m., hurricane force winds (winds of 74 miles per hour or greater) were experienced. The latter event appeared synchronous with the intensification of Wilma to category 3 (115 miles per hour) status around 1 p.m. of the same day. Wilma approached the southwestern shoreline of Grand Bahama and the Lucayan Harbour at high tide (1:49 p.m. EDT) and battered those areas with strong waves and high storm surges.

Measurements of meteorological parameters

Official anemometer readings from the Freeport Weather Services were not available; however, data from the NOAA National Weather Services Buoy at Settlement Point, just off West End recorded a sustained maximum wind of 82 knots (95 mph) with higher gust of 99 knots (114 mph).

Minimum pressure	28.64 inches
Rainfall measurement	40.4 mm (1.60 ins) duration unknown.

Damage

Wilma was the only cyclone that generated any damage of significance to the Bahamas during the 2005 season. Damage was estimated in the amount of USD 6,439,978 and ranged from widespread destruction of roofs and vehicles to the uprooting of poles and trees and the displacement of toms from the graveyard near the coast. The concentration of damages was mainly in the vicinities of the southwestern coastal area.

Storm surge

Storm surges of 12 feet or more were measured along the southwestern coastal areas.

Deaths

Only one death was reported. This was a result of the inundation of the storm surge in the settlement of Eight Mile Rock in Grand Bahama.

The warning system

The warning system proved most effective. The timely warnings significantly reduced the loss of lives and helped to mitigate losses to property.

BERMUDA

Bermuda was affected by directly by six (6) tropical cyclones in the 2005 hurricane season, none of which produced any serious injury, loss of life, or significant damage to property. Two Tropical Storm Watches, three Tropical Storm Warnings, one Hurricane Watch, and one local Gale Warning were issued in association with threats from tropical cyclones in the vicinity of Bermuda. Given the abundance of activity in the Atlantic during the 2005 season, it is unsurprising that Bermuda experienced effects from tropical cyclones in each month from July through October.

Tropical Storm Franklin

Tropical Storm Franklin formed from a tropical wave near the Bahamas and moved northeast, towards Bermuda. An approaching trough from the north, combined with instability created by Tropical Storm Franklin produced isolated thunderstorms over Bermuda on July 24th. At 0300 UTC, July 25th, Bermuda Weather Service issued a Tropical Storm Watch. Thunderstorms were widespread on July 25th as the outlying bands of Franklin moved over the Island. At 15 UTC on Tuesday 26 July Tropical Storm Franklin was located approximately 155 nm west (the closest point of approach to Bermuda). Gusts to 32 knots were recorded at the Bermuda International Airport at 19 UTC on the 26th, with occasional showers. The Tropical Storm Watch was ended at 0900 UTC on July 27, 2005.

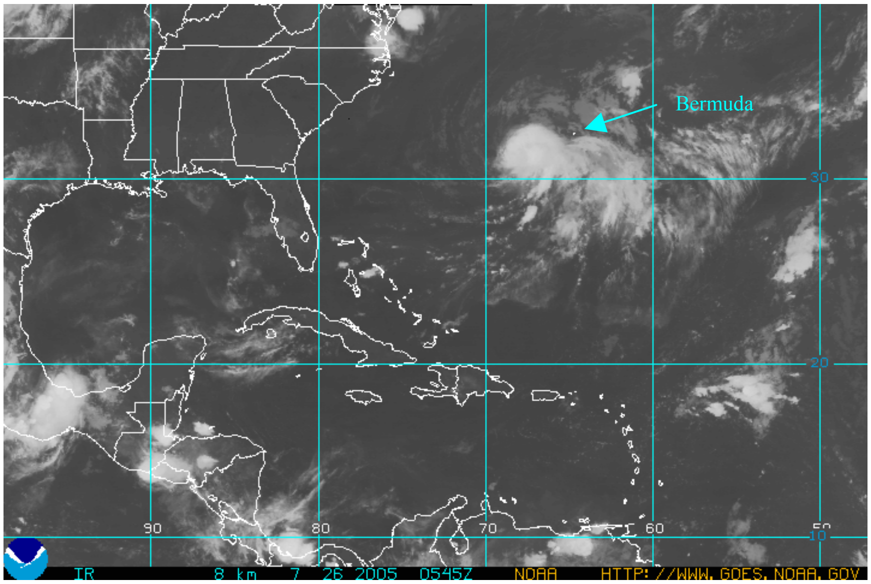


Figure 1: GOES Infrared imagery at 0545 UTC July 26, 2005, showing sheared TS Franklin to the west of Bermuda.

Tropical Storm Harvey

On August 2nd, Tropical Depression 8 was named by NHC to the southwest of Bermuda, with suggestions in the discussion that its origins and characteristics were borderline subtropical/tropical. The Bermuda Weather Service issued a Tropical Storm Warning on the first advisory on TD#8. The system was upgraded to Tropical Storm Harvey and began to approach the Island on August 3rd, causing thunderstorms and rain, with south-southeast winds increasing to moderate. The Tropical Storm Warning remained on August 4th, as Harvey brought thunderstorms, heavy showers and strong winds with a maximum recorded wind during the early morning of 33kt and gust 44kt. Mean wind speeds reached around 40kt at more exposed locations, such as Bermuda Harbour Radio. Conditions improved by the afternoon and the Warning was ended. As Harvey moved away on August 5th, skies cleared to mostly sunny and winds decreased to moderate from the north-northeast. Harvey produced 4.88 inches of rain over the island on the 3rd and 4th, passing 20nm south at 06 UTC on Thursday August 4th, 2005.

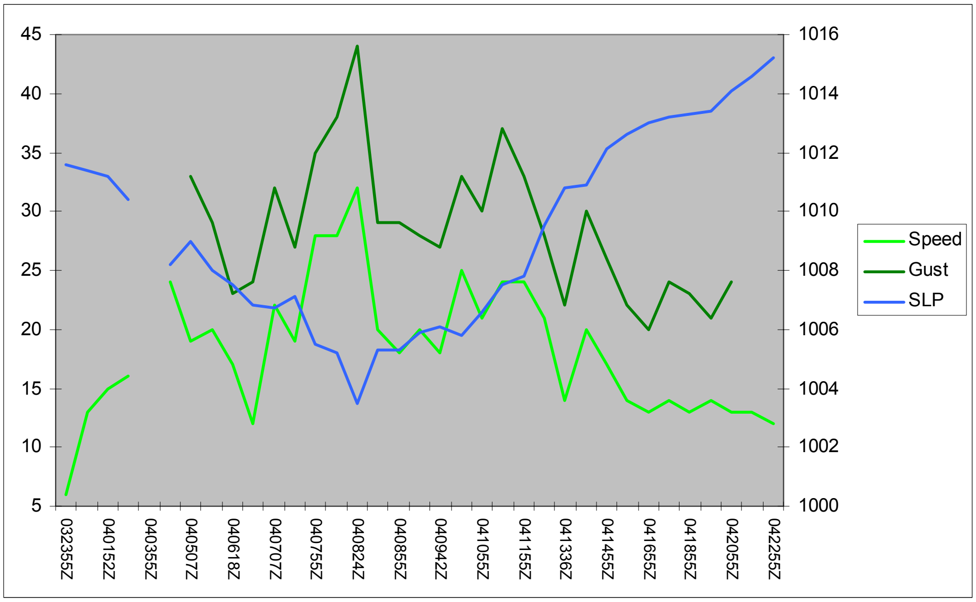


Figure 2: Data taken from the Bermuda International Airport METAR observations during Tropical Storm Harvey. All times are displayed in UTC.

Hurricane Nate

Tropical Depression 15 formed south of Bermuda, and was upgraded to Tropical Storm Nate by September 6th. On the 7th, Nate was upgraded to a hurricane and a Tropical Storm Warning and a Hurricane Watch were issued. Hurricane Nate slowly began to move towards Bermuda, causing a few showers and strong easterly winds by the end of the day. Hurricane Nate made its closest point of approach to Bermuda at 12 UTC on September 8th, 105nm to the south-southeast, bringing gusts up to 41 knots from the east, backing northeast, and widespread showers. Conditions began to improve on the 9th as Nate began to move away to the east. Data and imagery from the newly installed S-band Doppler Radar and AWOS stations were supplied to NHC.

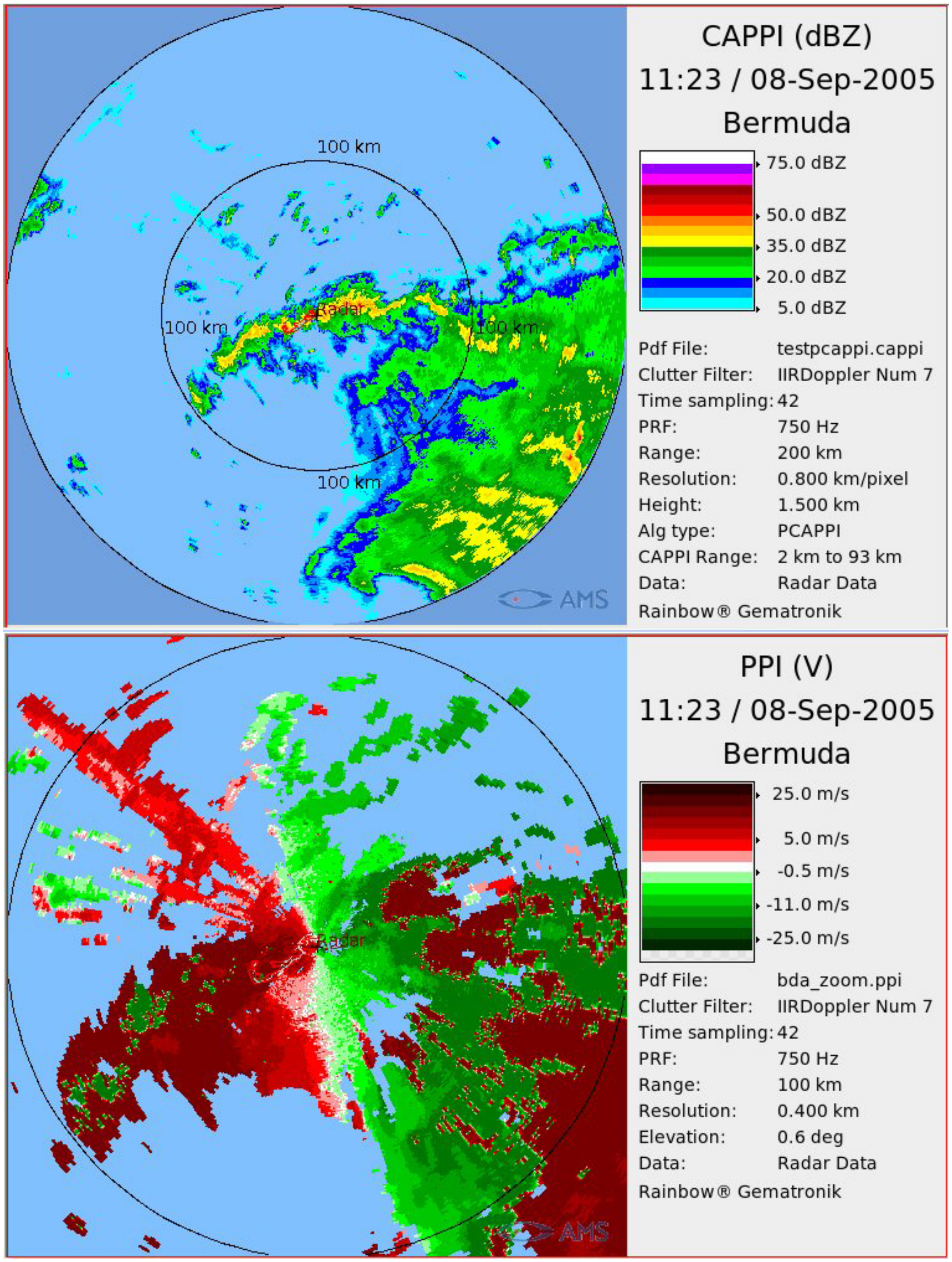


Figure 3: Radar reflectivity and velocity data displays during the passage of a rainband from Hurricane Nate, to the southeast of the island.

Hurricane Philippe

Tropical Depression 17 formed on September 17th from a tropical wave east of the Windward Islands, and was upgrade to Tropical Storm Philippe by the end of the day. Late on the 18th, NHC upgraded Philippe to a hurricane. During the next few days the characteristics and future development of Philippe were uncertain, due to vertical shear associated with an upper cut-off low to the southwest, and a broad upper trough associated with the outflow from intense

Hurricane Rita, in the Gulf of Mexico. Philippe was downgraded to a tropical storm again on the 20th, and began move closer to Bermuda on the 22nd, causing east northeasterly winds to increase to moderate. Tropical Storm Warning was issued early on the 23rd, but Philippe was rapidly dissipating. However, the storm was reincarnated as a new circulation, already at its closest point of approach 105nm to the southeast at 15 UTC, bringing strong northeasterly winds, cloudy skies, and showers through the 24th. The Tropical Storm Warning was continued until 21 UTC on the 23rd. The complicated interactions with the nearby cut-off upper low and (to a lesser extent) the outflow from Rita, made Philippe's intensity, structure and track considerably difficult to forecast.

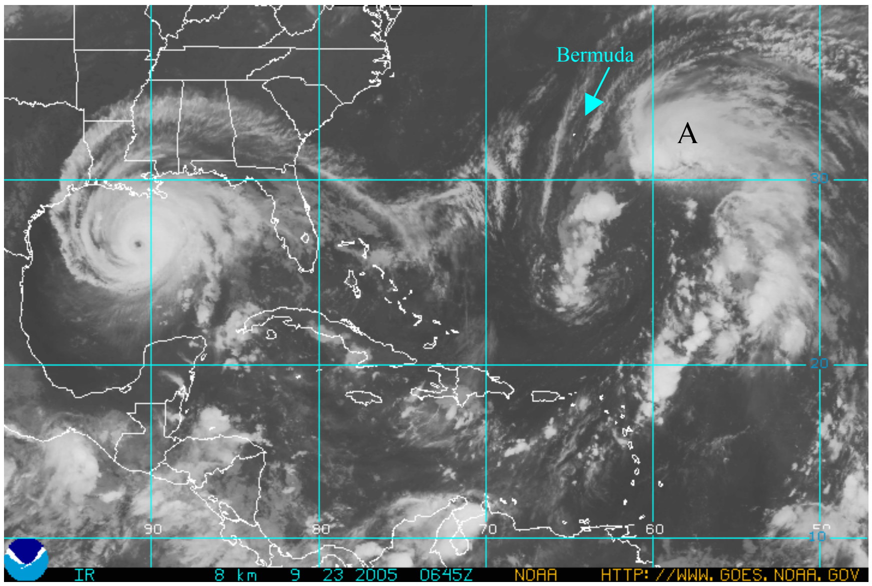


Figure 4: GOES infrared imagery from 0645 UTC September 23, 2005. The cold cloud tops designated by the 'A' in the figure is the convection associated with Hurricane Philippe. Also note the large upper circulation to the south of Bermuda, in which Philippe is embedded, and the outflow from Hurricane Rita, in the Gulf of Mexico.

Subtropical Depression 22

An area of low pressure formed near a cut-off upper low to the southeast of Bermuda, and was named Subtropical Depression 22 on the 8th. A Tropical Storm Watch was issued, and the system made its closest approach to Bermuda 220nm southeast at 03 UTC on Sun October 9th. The Tropical Storm Watch was ended later on the 9th, when the depression lost some of its tropical characteristics, and weakened slightly.

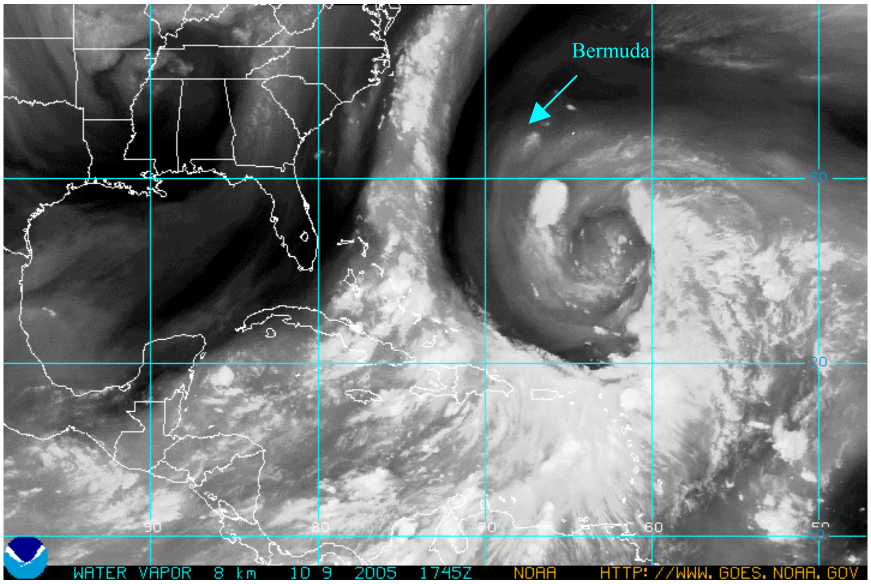


Figure 5: GOES water vapour imagery from 1745 UTC October 9, 2005. The large upper cut-off low to the south of Bermuda is associated with Subtropical Depression 22. Note the entrainment of dry air into the western and southern sectors of the depression.

Hurricane Wilma

After moving through the Caribbean Sea and Gulf of Mexico as a major hurricane, Wilma sped northeast from its landfall over Florida, under the influence of an upper mid-latitude trough. Hurricane Wilma made its closest point of approach 315nm west of Bermuda at 12 UTC on the 25thof October, causing tropical storm force winds and showers with a few thunderstorms. Winds decreased slightly as the day progressed, veering to the southwest, and continued to decrease through the early hours of the 26th as the remnants of Wilma moved away, however winds increased to moderate to strong from the west behind a cold front in the afternoon.

A Gale Warning had been issued by Bermuda Weather Service 36 hours prior to the onset of 34 knot winds, and at the time, there was some debate as to whether Wilma would be extratropical by its closest point of approach to Bermuda. After some discussion with NHC, it was decided by BWS to continue the local Gale Warning to avoid any public confusion or undue concern, rather than replace it with a Tropical Storm Warning. Even though Wilma was still a Category 2 hurricane at the time Bermuda was affected, there was high confidence in the track forecast and structure of the system, as it was embedded in a well-developed southwesterly steering flow ahead of a synoptic-scale trough. The NHC expanded the official 34kt wind radii on Advisory #41 (09 UTC, October 25), to just reach the island. There was no mention of Bermuda in the discussions, advisories, or in the final NHC TC Report on Wilma, despite winds of 35 knots being recorded at Bermuda International Airport, with gusts to 44 knots. Admittedly, Wilma was undergoing extratropical transition during its passage to the west and northwest of Bermuda, and its forward speed (46 knots) meant that tropical storm force winds would be short lived at Bermuda.

Also of interest during the passage of Wilma was the disruption of the flight patterns of certain birds. Most notable of these was the frigatebird, which according to local ornithologists is a rare visitor to Bermuda, and was sighted around the island in abundance for weeks after Wilma passed to the west.

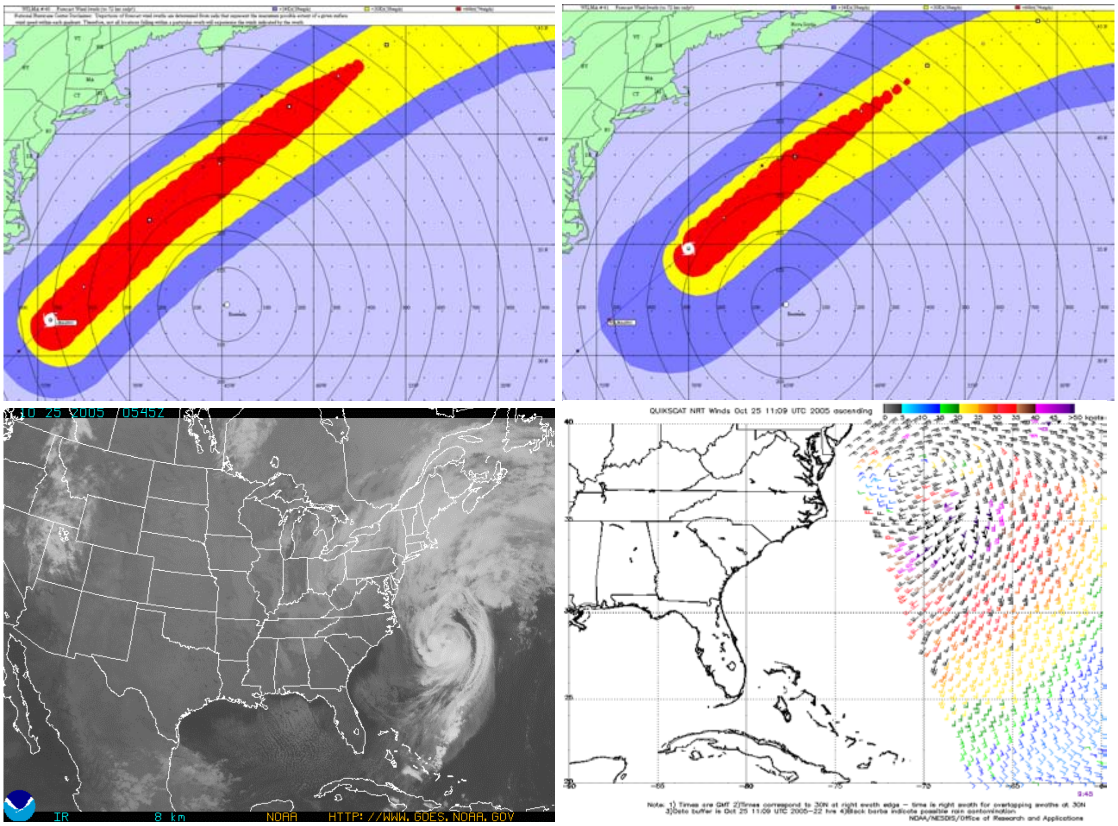


Figure 6 : Top panels show the forecast track and wind swath as of NHC Advisories 40 and 41, (left and right panels, respectively). The bottom left panel is a GOES infrared image from 0545 UTC October 25, 2005, showing Wilma to between the coast of the Carolinas and Bermuda. The bottom right panel is a QuikSCAT analysis from 1109 UTC October 25, 2005.

(available in Spanish only)

COSTA RICA

Los ciclones tropicales de 2006 manifestaron su influencia de formas diversas en Costa Rica. Los huracanes Dennis, Stan y Wilma y la tormenta tropical Gamma afectaron indirectamente al país. Los huracanes Emily y Beta, a pesar de su cercanía con respecto al país, no causaron precipitaciones significativas en Costa Rica.

Julio

Huracán Dennis: el flujo inducido sobre el país por este sistema produjo fuertes aguaceros (50-100 mm) e inundaciones en la región central el día 8 de julio.

Huracán Emily: a pesar de la trayectoria del sistema en el período 15-17 de julio, considerada crítica con respecto a los efectos previstos en Costa Rica, Emily no causó precipitaciones de considerable importancia. La razón de este comportamiento se debió a la estructuración de un sistema de baja presión en el océano Pacífico –cercano a Costa Rica-, lo que permitió, al mismo tiempo que el huracán se trasladaba hacia el norte del Caribe, que la Zona de Convergencia Intertropical se desplazara hacia el norte de Costa Rica, dejando al país en un área relativamente seca. El 15 de julio fue el día en que se manifestó de forma aislada el efecto del huracán, ya que se produjeron fuertes aguaceros en la región central del país, pero sin tener impactos locales o regionales considerables.

Octubre

Huracanes Stan y Wilma: las intensas y prolongadas precipitaciones en la región norte de la vertiente del Pacífico y el Valle Central se debieron a los efectos indirectos de los huracanes Stan (1-3) y Wilma (14-25). Se presentaron aguaceros de muy fuerte intensidad en el Valle Central, alcanzando valores de hasta 124 mm. Varios fueron los sectores en que las precitaciones sobrepasaron 100 mm en el Valle Central y la región norte del Pacífico.

Huracán Beta: este sistema fue relevante, no solo por su origen, trayectoria y cercanía al país, sino por su comportamiento dinámico y sus consecuencias en el tiempo del país. A pesar de que fue un huracán de categoría 3 muy cercano a las costas caribeñas de Costa Rica no generó precipitaciones significativas. La razón principal para tal efecto se debió a que el huracán Beta indujo viento del norte sobre el territorio nacional, desplazando, a su vez, la Zona de Convergencia Intertropical hacia el sur del país.

Noviembre

Tormenta tropical Gamma: este sistema, en su fase de depresión tropical, afectó la región sur de la vertiente del Pacífico del país. Se presentaron intensos aguaceros e inundaciones en varias partes de la región mencionada entre el 14 y 19. Se registraron 300 mm de precipitación en 48 horas, ocasionando inundaciones de significativa importancia.

FRANCE

(French West Indies – Martinique, Guadeloupe, St. Barthelemy and St. Martin)

Despite a “record” season over the whole Atlantic basin, the threat for the Lesser Antilles has been very light this year with only one “classic” Atlantic hurricane, Emily.

The forecasts from the 12th of July showed a possible northwestward track that led the Government of Martinique to issue a tropical storm watch but nothing really dangerous happened.

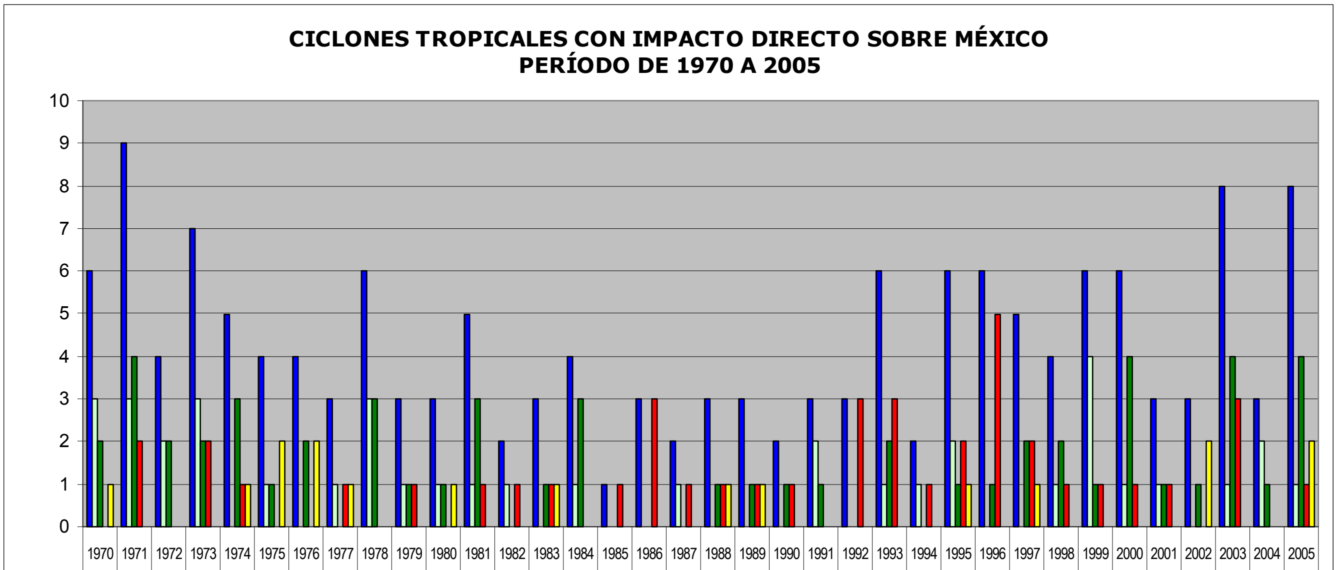
No watch nor warning have been issued for Guadeloupe, St Barthelemy and St Martin.

But note that, as during the previous year, due to a large wave that pushed the ITCZ up to the north near Martinique, one whole week of heavy rain occurred in November which caused floodings and specially flash floods resulting to 2 casualties in Martinique.

MEXICO

Una temporada **MUY ACTIVA** es la caracterización del comportamiento general de los ciclones tropicales durante el 2005 en México, con cifras muy por arriba del promedio anual de impactos directos sobre México. Afectaron directamente a costas nacionales ocho sistemas tropicales, siete provenientes del Atlántico (la mayor cifra del período de 1970 a 2005) y un solo ciclón proveniente del Pacífico.

El promedio de afectación directa de ciclones tropicales en México (por ambos océanos) del período de 1970 a 2005 es de 4.25 ciclones al año. La temporada 2005 sólo es superada por la actividad de 1971 que registró nueve impactos (seis de ellos originados en el Pacífico), la diferencia con la temporada del 71 es que durante ese año no se registraron impactos de huracanes intensos.



	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total CT	6	9	4	7	5	4	4	3	6	3	3	5	2	3	4	1	3	2	3	3	2	3	3	6	2	6	6	5	4	6	6	3	3	8	3	8
DT	3	3	2	3	0	1	0	1	3	1	1	1	1	0	1	0	0	1	0	0	0	2	0	1	1	2	0	0	1	4	1	1	0	1	2	1
TT	2	4	2	2	3	1	2	0	3	1	1	3	0	1	3	0	0	0	1	1	1	1	0	2	0	1	1	2	2	1	4	1	1	4	1	4
H1-2	0	2	0	2	1	0	0	1	0	1	0	1	1	1	0	1	3	1	1	1	1	0	3	3	1	2	5	2	1	1	1	1	0	3	0	1
H3-4-5	1	0	0	0	1	2	2	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	2	0	0	2

Figura 1. Estadística anual de impactos directos en México de Ciclones Tropicales por categoría del período de 1970 a 2005

Dos huracanes mayores o intensos golpearon a México, ambos de categoría IV en la escala de Saffir-Simpson, **"Emily" y "Wilma"**, siendo la temporada más relevante en este sentido, sólo comparable con la temporada de 1976, que también registró dos impactos de huracanes de categoría IV. Aunado a lo anterior, se registraron innumerables daños asociados al huracán **"Stan"** de categoría I en combinación con la migración hacia el norte del eje de la zona de convergencia intertropical y la influencia del factor orográfico en el Sureste de México. Asímismo, se registro el impacto en México de las tormentas tropicales, **"Bret", "Dora", "Gert" y "José"** y de la depresión tropical **"Cindy".**

Temporada de ciclones tropicales en el Atlántico

Durante esta intensa y muy prolongada temporada de ciclones en el Atlántico, de los treinta sistemas que se formaron, siete impactaron directamente a México, significando un record histórico.

El primero de ellos fue la **tormenta tropical "Bret",** la cual golpeo tierra firme en las cercanías de Tuxpan, Ver., en las primeras horas del día 29 de junio con vientos máximos sostenidos de 65 km/h, afectando con lluvias intensas a los estados de Veracruz, Tamaulipas, San Luis Potosí e Hidalgo. Se reportó una acumulación máxima en 24 horas de 266.0 mm en la estación de El Raudal, Veracruz. El SMN emitió un total de 11 avisos de "Bret". Protección Civil reportó oficialmente la muerte de una persona en el municipio de Cerro Azul y daños por el desbordamiento de un río en Naranjos, Veracruz.

El segundo ciclón de la temporada que afectó México fue **"Cindy"** (como **depresión tropical** número 3); tocó tierra al Sureste de Felipe Carrillo Puerto, Q. R., en la madrugada del día 4 de julio con vientos máximos de 55 km/h y lluvias fuertes con una acumulación máxima de 71 mm en Cancún, Q.R. El SMN emitió 17 avisos de "Cindy" y no se reportaron daños significativos.

El **intenso huracán "Emily"**; de categoría IV, impactó directamente a México, el día 18 de julio, después de las 2:00 de la mañana, en las inmediaciones de Tulúm, Q. R., con vientos máximos sostenidos de 215 km/h y posteriormente después de avanzar sobre el Noreste de la Península de Yucatán y retornar al Golfo de México, impactó en tierra por segunda ocasión durante el 20 de julio, entre las poblaciones de El Mezquite y Carboneras del municipio de San Fernando, Tamaulipas, como huracán de categoría III, con vientos máximos sostenidos de 205 km/h. En su recorrido por los estados de Tamaulipas y Nuevo León, "Emily" ocasionó lluvias torrenciales, con una acumulación máxima en 24 horas de 350.0 mm en Cerralvo, Nuevo León y una ráfaga de viento de 154.8 km/h en la estación automática de San Fernando, Tamps. El SMN emitió un total de 83 avisos sobre "Emily" y el Sistema Nacional de Protección Civil reporto daños en más de 50,000 hectáreas de cultivos en Tamaulipas, crecidas del río Santa Catarina y ningún deceso. La Secretaría de la Estrategia Internacional para la Reducción de Desastres de la Organización de las Naciones Unidas elogió la preparación de México para enfrentar al huracán "Emily".

La **tormenta tropical "Gert",** impactó en tierra durante el 24 de julio a 10 km al Sureste de Panuco, Ver. con vientos máximos sostenidos de 75 km/h y rachas de 100 km/h. En su recorrido afecto con lluvias intensas a los estados de Veracruz, San Luis Potosí, Tamaulipas y Nuevo León. La mayor acumulación lluvia en 24 horas se reportó en Tamuín, S.L.P. con 214.9 mm. No se reportaron daños ni muertes asociadas con Gert. El SMN emitió 14 avisos.

El quinto ciclón que afectó directamente a las costas de México por el Atlántico, fue la **tormenta tropical "José",** la cual tocó tierra durante la medianoche entre el 22 y el 23 de agosto, en las cercanías de la población de Vega de Alatorre, Veracruz, a 80 km al Nor-Noroeste del Puerto de Veracruz, Ver., con vientos máximos sostenidos de 85 km/h y rachas de 100 km/h. En su recorrido, "José" afectó con lluvias de fuertes a intensas a los estados de Veracruz, Puebla, Oaxaca, Tlaxcala, México y Distrito Federal. La acumulación máxima en 24 horas, se reportó en la estación de Misantla, Ver. con 255.0 mm. La racha máxima del viento fue de 70 km/h en la estación automática de Jalapa, Ver. Se registraron deslizamientos de lodo que ocasionaron cinco muertos en Oaxaca y uno en Veracruz. El SMN emitió un total de 13 avisos de "José".

El **huracán "Stan",** fue el sexto ciclón que afectó directamente a las costas orientales, impactó en tierra por primera vez sobre Quintana Roo, como tormenta tropical, aproximadamente a las 7:00 horas del día 2 de octubre, a 33 km al Este-Noreste de Felipe Carrillo Puerto con vientos máximos sostenidos de 75 km/h y rachas de 95 km/h. Después de cruzar la Península de Yucatán siguió su trayectoria sobre el Golfo de México rumbo hacia la costa sur de Veracruz y antes de las 10:00 horas del día 4 de octubre "Stan" tocó tierra por segunda ocasión, entre Punta Roca Partida y Monte Pío, a 20 km al Noreste de San Andrés Tuxtla, Ver., con vientos máximos sostenidos de 130 km/h, como huracán de categoría I. Los estados de Chiapas, Veracruz, Oaxaca, Puebla y Quintana Roo fueron afectados por la circulación de "Stan". La máxima acumulación de la lluvia en 24 horas se registró en la estación de El Novillero, Chiapas con 307.0 mm.

La interacción de la circulación de "Stan" con el desplazamiento hacia el norte de la zona de convergencia intertropical y el efecto de intensificación por la abrupta orografía en el estado de

Chiapas, ocasionó lluvias torrenciales por más de 4 días, generando el desbordamiento de 93 ríos, daños materiales totales y parciales en 47,638 viviendas, 653 carreteras afectadas, 270 puentes destruidos, daños importantes en cultivos, escuelas y en la infraestructura eléctrica. Protección Civil reportó un total de 80 muertes asociadas directamente con “Stan”. El SMN emitió un total de 33 avisos.

El último ciclón tropical que afectó directamente las costas de México por el lado del Atlántico fue el **intenso huracán “Wilma”,** el día 19 de octubre por la mañana, cuando su centro se localizaba a 520 km al Este–Sureste de Punta Allen, Q.R., presentó vientos máximos sostenidos de 280 km/h y la presión más baja registrada por el Centro Nacional de Huracanes de Estados Unidos en toda la historia de los ciclones en el Atlántico con 882 hPa. El día 21 de octubre a partir de las 9 horas, la muralla que rodea al ojo del huracán avanzó sobre la isla de Cozumel, la cual, tres horas después, quedó completamente inmersa por el ojo del huracán, mientras mantenía vientos máximos sostenidos de 230 km/h y un muy lento avance hacia el Oeste-Noroeste.

Aproximadamente a las 20:30 horas el ojo del huracán impactó tierra firme, sobre Puerto Morelos, Q. R., con vientos máximos sostenidos de 220 km/h y rachas de 270 km/h, como un sólido huracán de categoría IV.

Los efectos destructivos de “Wilma” fueron mayores debido a que por su lento y errático desplazamiento, se registrarón vientos de huracán por más de 50 horas consecutivas en la península de Yucatán. La más intensa rafága de viento fue reportada por la estación automática de Cancún con 210 km/h (antes de dañarse). La cifra más sobresaliente por “Wilma” fue la acumulación de la lluvia en 24 horas, el record histórico de México, con una cantidad de 1,576 mm en la estación automática de la Marina localizada en Isla Mujeres, Q. R. Se reportaron innumerables daños en la zona turística de Cancún, Riviera Maya, Isla Cozumel e Isla Mujeres. Oficialmente protección civil, reportó 4 muertes directas por “Wilma”. El SMN emitió un total de 88 avisos sobre “Wilma”.

Temporada de ciclones tropicales en el Pacífico Nororiental

Durante la pasada temporada de ciclones tropicales del Pacífico se originaron un total de 16 sistemas, de los cuales uno sólo se aproximó a territorio mexicano.

La tormenta tropical “Dora” durante la noche del 4 de julio, cruzó a tan sólo 25 km al Sur de las costas de Guerrero con vientos máximos sostenidos de 65 km/h. En su aproximación y recorrido ocasionó lluvias intensas en los estados de Oaxaca, Guerrero, Michoacán, Colima y Jalisco, con una acumulación máxima en 24 horas de 166.0 mm en la estación de Las Vigas, Gro. El SMN emitió un total de 19 avisos de “Dora” y no se reportaron daños significativos, ni muertes asociadas.

Funcionamiento del Sistema de Aviso en el Servicio Meteorológico Nacional de México

El Servicio Meteorológico Nacional mantuvo la vigilancia permanente de los ciclones tropicales a lo largo de la temporada 2005. En el Pacífico se emitieron un total de 286 avisos de ciclón tropical y 400 boletines de vigilancia. En el Océano Atlántico, se generaron 270 avisos y 366 boletines de vigilancia permanente.

Cuadro resumen de los Ciclones Tropicales durante la temporada 2005 en México

Ciclón Tropical	Recorrido Kms	Duración Horas	Total de Avisos	Entrada a tierra en México		Lluvia máxima en 24 h en mm	Daños humanos y materiales (*)
				Lugar	Vientos máximos km/h		Decesos
TT. Bret	435	29	11	Tuxpan, Ver.	65	266.0 mm en El Raudal, Ver.	1
DT. Cindy (3)	1,605	84	17	Felipe Carrillo Pto. Q.R.	55	71.0 mm en Cancún, Q.R.	0
TT. Dora	1,105	54	19	25 km al Sur de la costa de Gro	65	166.0 mm en Las Vigas, Gro.	0
H4. Emily	6,623	246	83	Tulúm, Q.R. [San Fernando, Tamps.]	215 [205]	350.0 mm en Cerralvo, N.L.	0
TT. Gert	895	42	14	Panuco, Ver.	75	214.9 mm en Taquín, S.L.P.	0
TT. José	568	32	13	Vega de Alatorre, Ver.	85	255.0 mm Misantla, Ver.	6
H1. Stan	1,545	96	33	Felipe Carrillo Pto., Q.R. [San Andres Tuxtla, Ver.]	75 [130]	307.0 mm El Novillero, Chis.	80
H4. Wilma	2,770	216	88	Cozumel, Playa del Carmen, Q.R.	230	1,576 mm Is. Mujeres, Q.R.	4

** Cifras de daños humanos y materiales proporcionadas por la Coordinación General de Protección Civil. Secretaría de Gobernación.*

Fenómenos hidrometeorológicos en México durante 2005

Durante el año 2005, el territorio mexicano, fue afectado por el paso de 8 ciclones tropicales, 55 frentes fríos, 46 ondas tropicales y 5 tormentas invernales (bajas frías). El SMN registró un total de 478 tormentas severas (umbral superior a 70 mm/24 h), destacando la máxima acumulación en Isla Mujeres, Quintana Roo, durante el 22 de octubre con 1,576 mm (récord histórico en México), ocasionada por el intenso huracán “Wilma”. El desastre de mayores proporciones fue, sin lugar a dudas, la inundación violenta con el desbordamiento de 93 ríos ocurrida entre el 4 y 6 de octubre en Chiapas con lluvias intensas asociadas con el huracán “Stan” que ocasionaron la pérdida 80 vidas humanas; daños materiales totales y parciales en 47,638 viviendas, 653 carreteras afectadas, 270 puentes destruidos, daños importantes en cultivos, escuelas y en la infraestructura eléctrica. En ambos casos, el SMN difundió avisos de tormentas intensas con especial enfásis en la ubicación del potencial de tiempo severo.

NICARAGUA

Tropical Storm Arlene

Arlene brought moderate precipitations over Nicaragua with significant maximum accumulated rainfall in 24 hours of up to 117 ml in Corinto. Electrical storms were associated with these rains.

Hurricane Dennis

Dennis did not have any direct effect on Nicaragua. Despite its close proximity to Central America, it did not develop spiral bands south of its centre. However, light indirect precipitation was experienced when the system's centre was located over western Cuba and west of the Florida Peninsula on 9 July. Maximum accumulated rainfall indirectly generated by this system reached 56 ml and 40 ml in Rivas and Jinotega respectively, due to the south-westerly wind produced by the extensive cyclonic circulation of this tropical cyclone over our country.

Hurricane Katrina

Hurricane *Katrina* did not directly affect Nicaragua. However, its indirect effects were felt when the system reached the middle of the Gulf of Mexico in its northward path. This system's extensive cyclonic circulation and a west-south-westerly wind bringing humidity to the interior from the Eastern Pacific Ocean also produced light to moderate rainfall, with maximum accumulated rainfall of between 35 ml and 39 ml in Managua, between 2 ml and 39 ml in Ocotal, and between 16 ml and 32 ml in San Carlos.

Hurricane Rita

Rita produced indirect effects on Nicaragua when the system was located in the middle of the Gulf of Mexico, where extensive cyclonic circulation brought a west-south-westerly wind over the country, transporting humidity from the Pacific Ocean to the interior of the country. These in turn caused light to moderate rainfall, mainly in the Pacific region and in the south of the country.

Hurricane Stan

Stan lasted approximately five days from the time it was located as a tropical disturbance in the Gulf of Honduras until it developed into a tropical depression over Mexico. However, the extensive cyclonic circulation generated by this system and the atmospheric instability it produced on Central America's Pacific coast lasted for almost a week, with continued rainfall since the remnants of *Stan* were positioned close to Acapulco as a low pressure centre of 1001 hPa. Significant accumulated rainfall was experienced in the Pacific region and mainly in the western parts of the country, with daily maximums of between 52.7 ml and 218.9 ml between 1 and 4 October.

Hurricane *Beta*

In the afternoon of 26 October a low pressure system developed into tropical depression No. 26 and subsequently tropical storm *Beta* in the early hours of 27 October approximately 125 km south of the island of San Andrés and some 230 km to the east-south-east of Bluefields, Nicaragua. It moved slowly in a north-north-easterly direction at 7 km per hour, until it reached a latitudinal position where it encountered favourable conditions that enabled it to develop into a hurricane. It had maximum sustained winds of 65 km per hour and minimum central pressure of 1005 hPa.

It gained strength and became a Category 1 hurricane in the early hours of 29 October, when its centre was located at approximately 210 km to the east of Puerto Cabezas, Nicaragua, and battered the islands of San Andrés and Providencia. It maintained a slow north-westerly course at 6 km per hour and due to the low velocity of the system's steering or prevailing winds and surrounding areas of high pressure, it pursued a very erratic path, at times even remaining stationary. At such times maximum sustained winds were recoded at 130 km per hour, with stronger gusts and a minimum central pressure of 985 hPa.

On 29 October, *Beta* continued to approach Nicaragua's Caribbean coast. At 9 p.m. local time, the system was upgraded to a Category 2 hurricane, with its centre located some 75 km east-south-east of Puerto Cabezas, Nicaragua, on a westerly course at 7 km per hour. It had maximum sustained winds of 165 km per hour with stronger gusts and a minimum central pressure of 970 hPa. Almost two hours later the system headed west-south-west, moving away from Puerto Cabezas and intensifying slightly, but it was in the early hours of 30 October (around 2 a.m. local time) that, before hitting Nicaragua, *Beta* was upgraded to a Category 3 hurricane, just off Nicaragua's eastern coastline, with the eye of the system located at 110 km to the south of Puerto Cabezas. Maximum sustained winds were recorded at 185km per hour, with stronger gusts and a minimum central pressure of 960 hPa.

In the early hours of 30 October *Beta* made landfall on the eastern coast of Nicaragua, close to the village known as la Barra del Río Grade, in Sandy Bay Sirpe as a Category 2 hurricane, before being downgraded to a Category 1 hurricane, losing strength rapidly on land as its velocity increased to 11 km per hour, maintaining a west-south-westerly course, blowing clouds and strong winds over Nicaragua and Honduras.

Beta continued its path over land in the afternoon of the same day and was downgraded to a tropical storm as it shifted to the west of the country until it lessened into a low pressure centre, leaving Nicaragua for the eastern Pacific Ocean.

<u>Impacts</u>

Beta lasted six days from the time it formed into a tropical depression until it dissipated over Nicaragua. It directly affected Nicaragua and the greatest damage was caused in areas of direct impact in the South Atlantic Autonomous Region of Nicaragua. There was significant precipitation in the North Atlantic Autonomous Region and the central and northern regions of the country. Puerto Cabezas recorded approximately 100 mm of rainfall in less than 24 hours. Maximum sustained winds caused structural damage to houses in the area of direct impact (see isohyet map for relevant period).

TROPICAL CYCLONES IN THE NORTH PACIFIC BASIN THAT AFFECTED NICARAGUA

Hurricane Adrian

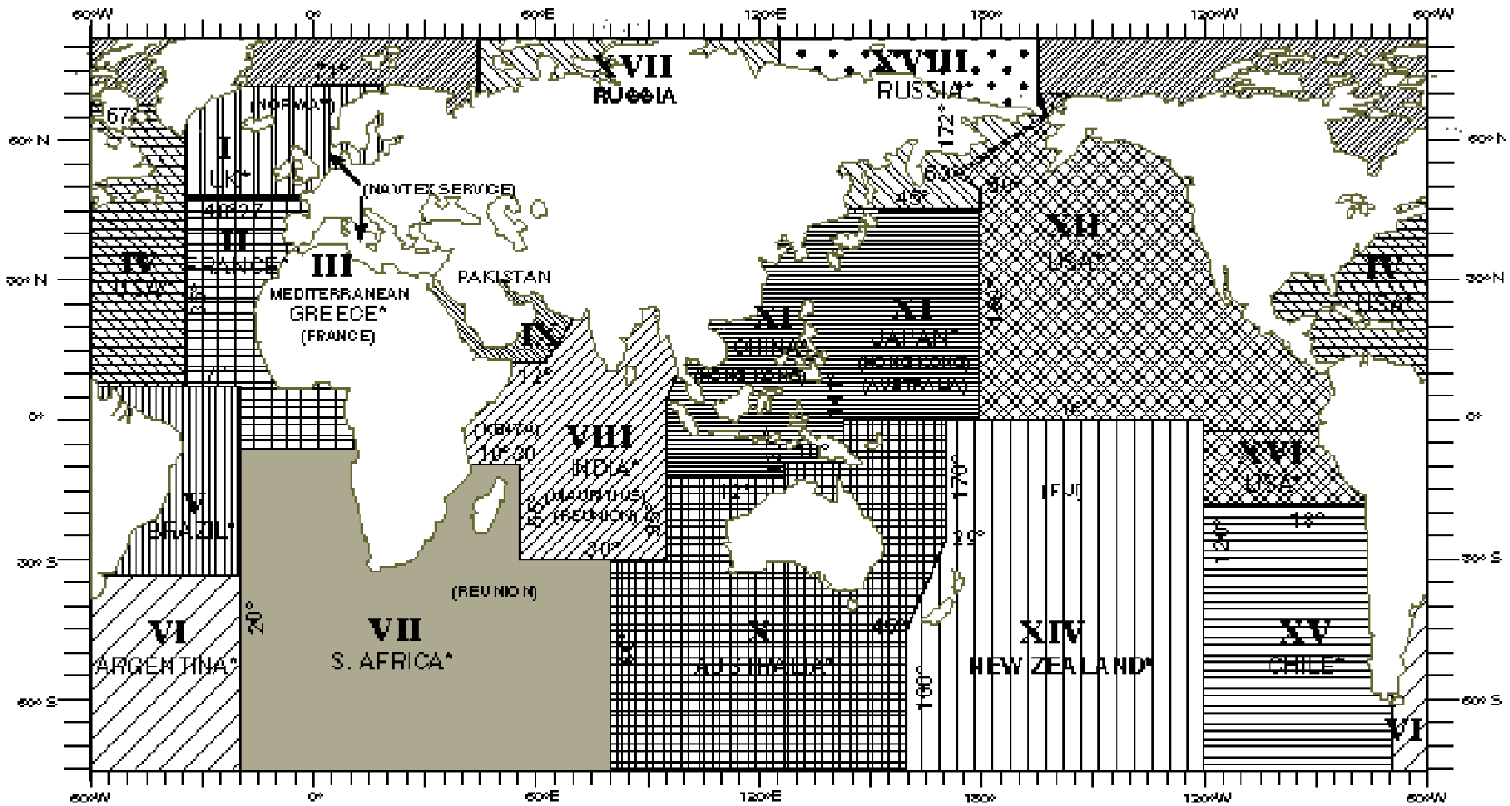
Adrian had a life span of five days from the time it formed into tropical depression No. 1-E until it dissipated over land. It was the only tropical system that occurred in May. In Nicaragua the most significant precipitation associated with *Adrian* was produced between 19 and 20 May, when this weather phenomenon approached the Pacific coast, blowing a west-south-westerly wind over the country, conducive to precipitation. Maximum accumulated rainfall in 24 hours was recorded at approximately 33.5 mm in Managua, 99.4 mm in Chinandega, 98.3 mm in Masatepe and 88.5 mm in Rivas

CONCLUSIONS

October was the most active month in Nicaragua in terms of cyclonic activity, mainly with the direct impact of hurricane *Beta*.

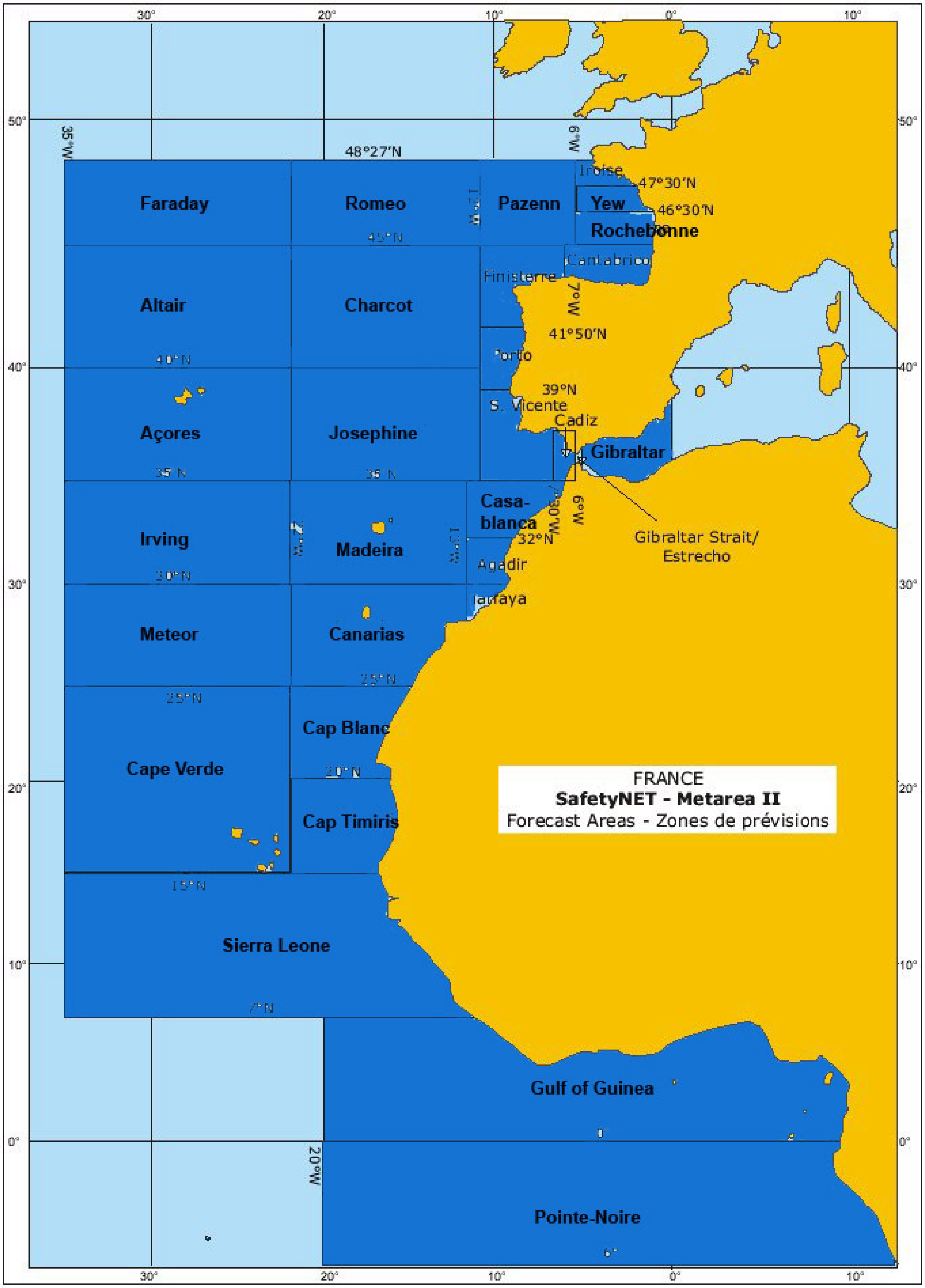
This rainy and hurricane season for Nicaragua was very active in terms of semi-persistent rainfall, due to the movement of 47 tropical waves over the country, some of which were due to tropical cyclones. The country was indirectly affected by tropical storm *Arlene*, followed by hurricanes *Dennis, Katrina and Rita*, directly affected by hurricane *Beta* and finally, indirectly affected by tropical storm *Gamma*.

In the Eastern North Pacific Basin the only indirect effects felt were those of hurricane *Adrian*.



* Denotes a preparation and issuing member ( ) Denotes a preparation member

METAREAS (Marine Forecast Areas)



France’s Marine Area of Responsibility in the Eastern Atlantic Ocean (Ref: WMO)

APPENDIX IX

RA IV HURRICANE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.1 DEVELOPMENT OF METEOROLOGICAL SERVICES									
1.1.1	Development and provision of adequate staff and equipment to enable the national Meteorological Services in the area to meet their responsibilities in the provision of hurricane warning services						Members	National and external assistance	
1.1.2	Full implementation of the observing, telecommunication and data-processing systems of the World Weather Watch in the hurricane area						Members	National and external assistance	With advice of WMO, where needed
1.2 METEOROLOGICAL OBSERVING SYSTEM									
1.2.1	Manned surface stations								
1.2.1.1	Assignment of the highest priority to the removal of deficiencies in the synoptic observation programmes at 0000 and 0600 UTC at stations of the RA IV regional basic synoptic network lying in the area between latitudes 5°N and 35°N, and between longitudes 50°W and 140°W*						Members	National	

*During 2006-2007 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.2.1.2	Investigation of the possibilities of establishing simple stations which may be operated by volunteers and would supply hourly observations of direction and measured wind speed and atmospheric pressure only during periods (hours) that a hurricane is within about 200 km of the stations						Members with large land masses	National	Such stations could suitably be placed where stations of the WWW network are more than 200 km apart.
1.2.1.3	Introduction of the practice of requesting stations along the shore to provide observations additional to those in the regular programme during hurricane periods, in particular when required by the RA IV Hurricane Operational Plan*						Members	National	
1.2.1.4	Expand the synoptic observation network of the RAIV in the area between latitudes 5ºN and 35º and longitude 50ºW and 140ºW.						Members	National	

*During 2006-2007 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE 2006	2007	2008	2009	2010	BY WHOM	RESOURCES	COMMENTS
1.2.2	Upper-air stations								
1.2.2.1	Establishment of the following upper-air stations: ✐ Guatemala ✐ 80400 Isla de Aves - radiosonde						Guatemala Venezuela	) National and) external) assistance	
1.2.2.2	Implementation of two radiowind observations per day at all radiowind stations throughout the hurricane season*						Members concerned	National and external assistance	
1.2.2.3	Maintaining two radiowind observations per day whenever a named hurricane is within 1,000 km of the station, until the requirements of paragraph 1.2.2.2 above can be accomplished*						Members	National	

*During 2006-2007 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.2.2.4	Implementation of the upper-air observations required at 0000 GMT under the World Weather Watch plan to enable a sufficient coverage during night hours						Members concerned	National and external assistance	
1.2.3	Ships' weather reports								
1.2.3.1**	Continuation of efforts to recruit ships for participation in the WMO Voluntary Observing Ship Scheme, in particular by :								
	• Recruiting selected and supplementary ships plying the tropics*						Members	National	
	• Designating Port Meteorological Officers*						Members	National	
1.2.3.2	Improvement of liaison between Meteorological Services and Coastal Radio Stations and arrangements for specific requests for ships' reports from any area of current hurricane activity even if such reports have to be transmitted in plain language*						Members operating coastal radio stations	National	

* During 2006-2007 items with an asterisk to be given priority attention
** Concern expressed regarding disclosure of ship position due to security reasons

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.2.4	Automatic weather stations								
1.2.4.1	Exploration of the possibility of installing automatic reporting devices at stations with insufficient staff for operation throughout the 24 hours; such stations might then be operated during daylight hours as manned stations and during night-time as unattended automatic stations, possibly with a reduced observing programme						Members concerned	National and external assistance	
1.2.4.2	Exploration of the possibility of installing automatic weather stations at locations which may be considered critical for the hurricane warning system for operation at least during the hurricane season						Members concerned	National and external assistance	

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.2.4.3	Establishment of automatic weather stations at the following locations: Dominican Republic (31) Colombia (185) * Bermuda (6) Honduras (12)						Dom. Rep. Colombia Bermuda Honduras	National & USA National and external assistance	The USA requested that countries planning to install automatic weather stations which use the GOES satellite for collection consult early with NOAA concerning details of the station configuration and transmission code formats which should be in WMO formats if possible

The Bahamas, Cuba, St. Lucia, Mexico, Colombia,and Nicaragua have completed these tasks. Honduras installed 3 AWS by the end of 2004. Bermuda has installed 5 and will install 1 in 2006.

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE 2006	2007	2008	2009	2010	BY WHOM	RESOURCES	COMMENTS
1.2.5	Radar stations								
1.2.5.1	Promotion of the establishment and operation of a sub-regional network of 10 cm/5.6 cm wavelength radar stations, including replacement of unserviceable radars* • Replacement of radars in Barbados, Belize, Trinidad & Tobago • Replacement of radar in St. Marteen						Barbados, Belize,Trinidad &Tobago Netherlannd Antilles	National and European Union	Being implemented
1.2.5.2	Establishment and operation of 10 cm/5.6 cm wavelength radar stations at the following locations or nearby: • On the Central American coast (within longitudes 82° and 92°W and latitudes 10° and 16°N) either in Central America • Honduras • Guatemala (2) • Venezuela (3 more)						Costa Rica, Nicaragua, El Salvador. Guatemala Venezuela	)))) National and) external) assistance))	CRRH developing a project for Central America

*During 2006-2007 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.5.3	Speedy availability of 10 cm/5.6 cm radar information, and particularly eye-fixes, to all other countries in the hurricane area in accordance with the Hurricane Operational Plan for Region IV*						Members operating 10 cm/5.6 cm radar stations	National	
1.2.5.4	Development of pictorial radar information sharing programme including composites among all RA IV countries in the hurricane area in accordance with the Hurricane Operational Plan*						France	USA and France	France will produce composites and the USA provide the telecommunication facilities

*During 2006-2007 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.6	Air reconnaissance flights								
1.2.6.1	Continue provision of aircraft reconnaissance when required in accordance with the Hurricane Operational Plan for Region IV and dissemination of the information obtained to all concerned*, whenever this activity is not in violation of the sovereignty of the countries concerned.	—	—	—	—	—	USA	USA	

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.7	Meteorological satellite systems**								
1.2.7.1	Maintaining and operating the LRIT stations for the reception of cloud pictures from GOES and near-polar-orbiting satellites, including any modified or new equipment necessary for the reception of information from the POES series of satellites*						Members	National	
1.2.7.2	Installation and operation of direct read-out satellite reception facilities, in view of their great utility in hurricane tracking and forecasting*						Members able to do so	National and external assistance	
1.2.8	Storm surges								
1.2.8.1	Establishment of a network of tide-gauge stations in coastal areas where storm surges are likely to occur						Members able to do so	National	Data should be provided in near real-time

* During 2006-2007 items with an asterisk to be given priority attention
** Satellite technology has increased tremendously; met services should explore products

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.3 METEOROLOGICAL TELECOMMUNICATION SYSTEMS									
1.3.1	National telecommunication networks								
1.3.1.1	Provision of suitable telecommunication facilities for the collection at NMCs of all observational data from stations in the regional basic synoptic network in accordance with the requirements of the WWW (i.e. 95% of reports to reach the collecting centre within 15 minutes of the observing station's filing time)*						Members	National and external assistance	Take urgent action
1.3.2	Special hurricane telecommunication arrangements								
1.3.2.1	Implementation, where necessary, of communication links to enable direct contact between warning centres to permit direct communication between forecasters						Members	National	Use of systems such as VSAT is recommended
1.3.2.2	Implementation, where necessary, of national and international communication links for distribution of warnings and advisories						Members	National and external assistance	

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.3.3	Regional telecommunication network								
1.3.3.1	Continue to improve and upgrade telecommunication systems in accordance with the RA IV Regional Meteorological Telecommunication Plan,*						Members		
1.3.3.2	Promote installation of EMWIN systems						USA Members	External Assistance & National budget	

*During 2006-2007 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
1.4 HURRICANE AND STORM SURGE SIMULATION, FORECASTING AND WARNING									
1.4.1	Storm surge project								
1.4.1.1	Cooperation in activities to be undertaken on storm surges as a project of the WMO Tropical Cyclone Programme in the Hurricane Committee area*						Members	National and external assistance including TCDC	With advice of WMO
	• develop storm surge maps and undertake hazard assessment activities*						Members		Digitized format ; Resolution 0.1 to 1.0 nautical mile
	• undertake bathymetric and topographic data collection for vulnerable areas*						Members		
	• CIMH is developing storm surge hazard maps for CMO members*						CIMH		
	• Bahamas increasing its maps using SLOSH						Bahamas		

*During 2006-2007 items with an asterisk to be given priority attention

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.1 SUPPORT TO HYDROLOGICAL SERVICES AND FACILITIES									
2.1.1	Strengthening the national Hydrological Services and, in particular, improvement of the hydrological observing networks and data transmission and processing facilities**						Members concerned	National and external assistance	**This would include promoting the use of quantitative precipitation information from precipitation forecasts, surface radar networks and satellites, as considered in the meteorological component of the Technical Plan
2.1.2	Establishment and development of national and/or sub-regional hydrological workshops to repair and maintain hydrological instruments, and promotion of the establishment of sub-regional facilities for the calibration of these instruments						Members concerned	National and external assistance	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.2 HYDROLOGICAL FORECASTING									
2.2.1	Establishment, improvement and/or expansion of hydrological forecasting (including flash floods) and warning systems in flood-prone areas, and in particular: (a) The countries indicated to be invited to consider the establishment/ expansion of systems in the:							National	
	• YAQUE DEL SUR river basin • YAQUE DEL NORTE river basin						Dominican Republic		
	• RIO LEMPA						El Salvador and Honduras Guatemala		
	• International river, RIO GRANDE (RIO BRAVO) river basin						Mexico & USA		Additional data required
	• VIEJO,COCO and TUMA river basins						Nicaragua		
	• RIO PARRITA and RIO ESCONDIDO						Costa Rica		

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.2.1 (cont'd)	Establishment, improvement and/or expansion of hydrological forecasting (including flash floods) and warning systems in flood-prone areas, and in particular: (b) Establishment of flash flood warning systems in flood-prone areas; (c) Promote the use of hydrological models to forecast the behaviour of rainfall and run-off characteristics, paying special attention to the use of radar and satellite information.						Members concerned Members concerned	National National	A flash flood warning system was installed in 2003 and 2004 in Central America with support of the USA.
2.3 BASIC SUPPORTING STUDIES AND MAPS									
2.3.1	Determination of flood-prone areas; compilation of an inventory of existing hydrological observing, transmission and processing facilities in these areas; and determination of requirements for related meteorological services						Members concerned	National and external assistance	For these studies, use should be made insofar as possible, of previous experience of Member countries of the Committee

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.3.2	Implementation of hydrometeorological and rainfall-runoff studies (including depth-area duration-frequency analyses of rainfall) for use in planning and design						Members concerned	National and external assistance	
2.3.3	Carry out surveys as soon as possible, immediately following flood events for the purpose of delineating the limits of flooding. The survey should include if possible aerial and satellite imagery						Members concerned	National	
2.3.4	Preparation of flood risk maps in flood-prone areas for their use in: (a) Planning and undertaking preventive measures and preparations for flood mitigation; (b) Long-term planning covering land use						Members concerned	National	Members sharing basins encouraged to standardize the scales of these maps
2.3.5	Assessment of quantitative precipitation information from precipitation forecast, satellite, radar and raingauge networks for flood forecasting						Members concerned	National and external assistance including TCDC	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.3.6	Initiation of research studies and operational data collection for analysis and forecasting of combined effects of storm surge and river flooding phenomena** ** WMO Operation Hydrology Report No. 30 "Hydrological Aspects of Combined Effects of Storm Surges and Heavy Rainfall on River Flow"						Members	National and external assistance	For these studies, use should be made, insofar as possible, of previous experience of Member countries of the Committee
2.3.7	Basic studies on the vulnerability of the monitoring networks to damage caused by tropical storms, taking into account also the problems which might be generated when stations become inoperative, both with regard to the interruption of the available historical series and to the provision of observations and data of subsequent events						Interested Members	National and TCDC	
2.3.8	Basic studies on the intensity and spatial variability of rainfall produced by all tropical storms during the tropical cyclone season, as well as on the optimal density of the recording rainfall network required						Interested Members	National and TCDC	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.3.9	Preparation of flood-risk maps of zones susceptible to flooding caused by tropical storms, separating floods resulting from local rains from those resulting from rainfall in the headwaters of the basins						Interested Members		
2.3.10	Basic studies on the problems of operation of reservoirs when their basins are affected by rainfall produced by tropical storms and decisions to be made with respect to the water impounded						Interested Members	National and TCDC	
2.3.11	Initiation of a GIS-based database to be used by all countries of the region						Interested Members	National and TCDC	
2.3.12	Establishment of a regional project to generalize the hydrological impact knowledge of tropical storms and hurricanes**						Interested Members	National and TCDC	

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
2.4 TRANSFER OF HYDROLOGICAL TECHNOLOGY									
2.4.1	Attention to the availability through HOMS of components and sequences containing hydrological technology suitable for the hydrological component of the technical plan∗						Members	National and TCDC	With advice of WMO
2.4.2	Undertaking a promotional effort among Member countries, so that they may develop HOMS components reflecting in particular experiences in regions affected by tropical storms; the Committee to encourage the inclusion of the components in the HOMS Reference Manual						Hurricane Committee in cooperation with its Members	National and TCDC	

∗ These HOMS components include instrumentation and hydrological models for monitoring and forecasting the floods caused by all tropical storms during the tropical cyclone season. HOMS components also relate to flood damage estimation extent of flooding and flood-plain mapping.

** The meeting expressed a desire for the hydrology and meteorology group to be compatible and for the Working Group on Hydrology (RA IV) to consider technical plan for RA IV.

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
3.1 DISASTER REDUCTION									
3.1.1	Drawing the attention of national authorities of th e principal role of meteorological and hydrological factors in carrying out vulnerability analyses in the fields of physical and urban planning, land-use zoning, public works and building codes						Members	National, regional and international	
3.1.2	Promote public awareness of the hurricane risk and the associated risks prior to each hurricane season						Members	National, regional and international	
3.1.3	Participate actively in appropriate conferences and activities related to natural hazard mitigation and multi-hazard warning systems.						Members	National, regional and international	
3.1.4	Participate actively in the preparation and on-going review of the national disaster prevention and preparedness plans						Members	National	
3.1.5	Cooperate with all national and regional agencies in their annual pre-hurricane season exercises. Where these do not exist meteorological services should promote their implementation						Members	National and regional	

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
3.1.6	Promote good relationship with the media and make full use of their services to disseminate information prior to and during the hurricane season						Members	National, regional and international	
3.1.7	Arranging for the early transmission of forecasts of hurricanes and flooding to the central coordinating agency responsible for the organization of protective and relief measures, and to similar coordinating agencies at regional level, to allow the timely dissemination of warning by such agencies						Members	National and regional	
3.1.8	Participate in ensuring that official advisory statements concerning forecasts, warnings, precautionary actions or relief measures are only to be made by authorised persons and to be disseminated without alteration						Members	National, regional and international	
3.1.9	Advising on and contributing to training programmes to support preparedness programmes to include disaster administrators, disaster control executives and rescue/relief groups and workers in all counter-disaster authorities and agencies						Members	National, regional and international	

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
3.2 REVIEWS AND TEST EXERCISES									
3.2.1	Participating in periodic reviews of both disaster prevention and disaster preparedness plans to ensure that they are active and up to date						Members	National and external assistance	With advice of OCHA/IFRC/ CDERA
3.2.2	Conducting of periodic staff checks and test exercises to test the adequacy of NMHSs disaster preparedness plans, preferably on a progressive annual basis prior to the expected seasonal onset of natural disaster threats but also, in respect of plans to meet sudden impact disasters, on an occasional no-warning basis						Members	National	

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
4.1 TRAINING OF METEOROLOGICAL PERSONNEL									
4.1.1	Assessment of current and expected future needs for the training of specialized staff to man their warning systems at all levels under the following headings:								
	(a) Those capable of being met through training facilities already available in Member countries*						Members	National	
	(b) Those for which assistance from external sources is needed*						Members	National	With advice of WMO
	Take appropriate steps to organize such training programmes*						Members	National and external assistance	
4.1.2	Support as appropriate and make full use of the training facilities offered at the WMO Regional Meteorological Training Centres at the CIMH, Barbados, and the University of Costa Rica, San José, as well as at the Tropical Desk in Washington.						Members	National and external assistance	

*During 2006-2007 items with an asterisk to be given priority attention

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
4.1.3	Arrangements for short courses of approximately 2 to 3 weeks duration on topics related to storm rainfall estimation and to hurricane forecasting to be organized at the RSMC Miami Hurricane Center and the Regional Meteorological Training Centres at the CIMH and the University of Costa Rica*						Regional centres	Regional, national and external assistance	These events should be conducted in English and Spanish
4.1.4	Arrangements for periodic seminars or workshops on specific topics of particular interest for hurricane prediction and warning purposes, priority being given in the first instance to operational techniques for the interpretation and use of NWP products, satellite and radar data and to storm surge prediction						Members, Hurricane Committee	National and external assistance	
4.1.5	Arrangements for exchange working visits of Staff between operational and training centres						Members, training centres	National and external assistance, regional projects, TCDC	

*During 2006-2007 items with an asterisk to be given priority attention

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
4.2 TRAINING OF HYDROLOGICAL PERSONNEL									
4.2.1	Assessment of current staff availability and capabilities and future needs for training hydrologists in specific subjects concerning hydrological forecasting and warning and of hydrological technicians, to promote and take appropriate steps to organize and disseminate information on training courses, workshops and seminars, and in particular to support the following:						Members concerned	National and external assistance	
	(a) The establishment of a sub-regional centre in the Central American Isthmus for hydrological technicians' training;								
	(b) The training of operational hydrological personnel at the sub-regional (training) centre in the Caribbean;								
	(c) The organization of a course for training in tropical cyclone hydrology and flood forecasting.						USA or other Members concerned	National and external assistance	
	Courses and workshops on hydrological forecasting techniques or data acquisition, processing and analysis								

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
4.2.2	Arrangements for exchange working visits of staff between national hydrology and flood forecasting centres and regional hydrological training centres						Members, training centres	National and external assistance, regional projects, TCDC	

V. RESEARCH COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2006	2007	2008	2009	2010			
5.1 RESEARCH									
5.1.1	Making readily available information on research activities carried out in Member countries to other Members of the Committee*						Members	National	*WMO, when requested, to facilitate the exchange of information on these activities as well as on sources of data available for research
5.1.2	Formulation of proposals for consideration by the Committee for joint research activities to avoid duplication of effort and to make the best use of available resources and skills						Members	National	
5.1.3	Arrangements for exchange visits of staff between national research centres						Members	National and external assistance, regional projects, TCDC	

*During 2006-2007 items with an asterisk to be given priority attention

Appendix X

Status of Implementation of VCP Projects related to RA IV Hurricane Committee Members

31/01/06

Country	Project Indicator	Project Title	Circulation Year	Donor Support	Status of Implementation	Estimated cost
ANTIGUA AND BARBUDA	OB/2/3/2	Provision of an automatic weather station for Barbuda	2002	No	No support	
BAHAMAS	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station	2001	USA (bilateral) Full	Completed in August 2004	US $68,500
BAHAMAS	OB/2/1/3	Rehabilitation of the meteorological observing network after Hurricanes Frances and Jeanne	2005	No	No support	
BAHAMAS	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed in October 2003	US $44,000
BARBADOS	OB/1/2/3	Replacement of a standby electric generator for upper-air observations	2005	No	No support	
BARBADOS	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station	2001	USA (bilateral) Full	Completed ion 24/10/02	US $68,500
BELIZE	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	Completed in March 2003	US $60,000
BELIZE	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station	2001	USA (bilateral) Full	Completed in June 2003	US $68,500
BELIZE	OB/2/3/3	Provision of an automatic weather station	2001	No	No support	
BELIZE	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed on 15/03/04	US $44,000
BRITISH CARIBBEAN TERRITORIES	TE/2/3/1	Replacement of the RA IV RMTN workstation for Cayman Islands	2003	No	No support	
COLOMBIA	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station in San Andres	2001	USA (bilateral) Full	Completed on 15/12/04	US $68,500
COLOMBIA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed on 10/10/03	US $44,000
COSTA RICA	DP/4/2/1	Improvement of real-time data access at RMTC San José	2003	No	No support	
COSTA RICA	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	Completed in January 2001	US $35,000
COSTA RICA	OB/1/2/11	Provision of 400 GPS radiosondes and balloons	2001	USA (GCOS) Full	Completed in May 2004	US $77,900
COSTA RICA	OB/1/2/12	Provision of 400 GPS radiosondes and balloons	2004	USA (GCOS) Partial	Completed in January 2005	
COSTA RICA	OB/1/2/13	Provision of upper-air consumables	2006	No	No support	

Status of Implementation of VCP Projects related to RA IV Hurricane Committee Members

31/01/06

Country	Project Indicator	Project Title	Circulation Year	Donor Support	Status of Implementation	Estimated cost
COSTA RICA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed in March 2004	US $44,000
CUBA	OB/1/3/1	Provision of an electrolytic hydrogen generator	1996	CHINA Full	On-going	$46,380
CUBA	OB/2/2/1	Calibration of national standard barometers of the NMS	1997	FRANCE Full	Completed on 16/07/01	FF170,000
DOMINICA	OB/2/3/2	Provision of an automatic weather station for Melville Hall Airport	1998	FRANCE Full	Completed on 18/10/03	EUR 52,030
DOMINICAN REPUBLIC	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	On-going	US $120,000
DOMINICAN REPUBLIC	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station	2001	USA (bilateral) Full	Completed on 02/11/05	US $68,500
DOMINICAN REPUBLIC	OB/4/3/1 (Revised)	Upgrading of the Rainbow Program software and provision of a SUN workstation	2001	No	No support	
EL SALVADOR	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	On-going	US $55,000
EL SALVADOR	OB/2/2/1	Rehabilitation of the meteorological observing network	2002	No	No support	
EL SALVADOR	OB/2/2/1 (Revised)	Rehabilitation of the meteorological observing network	2005	No	No support	
EL SALVADOR	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	On-going	US $44,000
GUATEMALA	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	On-going	US $45,000
GUATEMALA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	On-going	US $44,000
HAITI	AEM/3/1/1	Provision of a satellite-based distribution system for WAFS data and products	1998	USA Full	Completed on 12/12/01	$46,500
HONDURAS	DP/1/1/1	Upgrading of a Synergie station to be Year 2000 compliant	1999	FRANCE Full	Completed on 16/01/01	FF99,000
HONDURAS	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	Completed on 30/07/03	US $240,000
HONDURAS	OB/1/2/10	Provision of one year supply of radiosondes and balloons	2002	No	No support	
HONDURAS	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed on 10/07/05	US $44,000

Status of Implementation of VCP Projects related to RA IV Hurricane Committee Members

31/01/06

Country	Project Indicator	Project Title	Circulation Year	Donor Support	Status of Implementation	Estimated cost
JAMAICA	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station	2001	USA (bilateral) Full	On-going	US $68,500
JAMAICA	WCP/2/1/3	Upgrading of a CLICOM system	1999	VCP(F) Full	Completed on 20/09/01	$3,500
NETHERLANDS ANTILLES AND ARUBA	OB/1/3/1	Provision of two electrolytic hydrogen generators for the upper-air stations in Curaçao and St. Maarten	2001	USA (bilateral) Full	Completed on 02/05/03	US $137,000
NETHERLANDS ANTILLES AND ARUBA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed on 28/11/03	US $44,000
NICARAGUA	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	On-going	US $85,000
NICARAGUA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	On-going	US $44,000
PANAMA	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	Completed in 2002	US $110,000
PANAMA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	On-going	US $44,000
TRINIDAD AND TOBAGO	OB/1/3/1	Provision of an electrolytic hydrogen generator for the upper-air station	2001	USA (bilateral) Full	Completed on 22/11/02	US $68,500