WORLD METEOROLOGICAL ORGANIZATION

TWENTY-SEVENTH SESSION

RA IV HURRICANE COMMITTEE

SAN JOSÉ, COSTA RICA

(31 MARCH TO 5 APRIL 2005)

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 Costa Rica, the twenty-seventh session of the RA IV Hurricane Committee was held at the Tryp Corobici Hotel, in San José, Costa Rica from 31 March to 5 April 2005. The opening ceremony commenced at 09:00 hours on Thursday, 31 March.

1.1.2 Mr Paulo Manso, Permanent Representative of Costa Rica with WMO, welcomed the participants of the Hurricane Committee. He stated that losses from weather, climate and water-related disasters continued to increase. Mr Manso mentioned that while natural hazards might not be avoided, our efforts in strengthening pre-disaster strategies such as integration of risk assessment and early warnings should be stressed.

1.1.3 Mr Katsuhiro Abe, the WMO Secretariat representative, welcomed the participants on behalf of Mr Michel Jarraud, Secretary-General of WMO, and expressed the appreciation of WMO and gratitude to the Government of Costa Rica for hosting the twenty-seventh session of the Committee in the beautiful city of San José. He stated that the Secretary-General emphasized his interest in the important work being done under the RA IV Hurricane Committee, especially in the context of Sustainable Development of Small Island Developing States and International Strategy for Disaster Reduction (ISDR). Mr Abe stressed that a well-functioning early and timely-warning system is one of the most effective measures for disaster reduction.

1.1.4 The Chairman of the Hurricane Committee, Mr Max Mayfield (USA), expressed his appreciation to the Government of Costa Rica for the kind invitation to host the session of the Committee. He congratulated the Committee Members for the outstanding team effort that occurred during the 2004 hurricane season which was one of the most devastating on record. Mr Mayfield challenged Committee Members to share lessons learnt and to focus on ways to change the outcome in regard to saving lives and protecting property during future tropical cyclone events. The Chairman acknowledged the WMO, and Mr Katsuhiro Abe in particular, for the support to the Region's hurricane programme. He also noted the passing of Mr Bert Berridge and Mr Deighton Best during the past year. Both of these men made significant contributions to the Region and will be missed.

1.1.5 The Vice-Minister, Ministry of Environment and Energy of Costa Rica, Mr Allan Flores, welcomed all participants and thanked WMO for the opportunity given to Costa Rica to hold an international meeting of the stature of the Hurricane Committee in San José. He mentioned the cost of human, social and environmental damage from natural disasters such as tropical storms. Mr Flores stressed the need for the use of new technology and technical cooperation among countries in order to minimize the vulnerability to tropical cyclones. He concluded by formally declaring the session open.

1.1.6 The Committee observed a minute of silence in honour of the late Messrs Cyril Egbert (Bert) Berridge (former Permanent Representative of the British Caribbean Territories and Dominica with WMO, and a vice-president of WMO) and Deighton Fenwick Best (former Permanent Representative of Barbados with WMO).

1.1.7 There were 47 participants at the session from 24 Members of the RA IV, including eight observers from 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 Regional Association IV (RA IV) Members in the coordination of watches and warnings during the tropical cyclone events of 2004. The 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 This year RSMC Miami would introduce an *experimental* product providing the one to five day wind speed probabilities for tropical cyclones. This product would be available on the RSMC Miami web page.

2.3 In the USA, 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 is activated to assist with the coordination among 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 USA. The NOAA Hydrometeorological Prediction Center (HPC) in Washington is the back-up center – or provides back-up arrangements for the RSMC Miami and routinely prepares the five-day track forecast in case the back-up is invoked.

2.4 During the 2004 season, three meteorologists from RA IV gained valuable experience in hurricane operations through their participation in the RSMC Miami attachment. Mr Alvaro Palache from Venezuela, Ms Mercedes Mejia from the Dominican Republic and Mr Jean Noël De Grace from Martinique (France), helped improve hurricane warning coordination in the Region during many of the tropical cyclone events. Regrettably, the training in hurricane forecasting was limited during the period of unprecedented hurricane landfall threats. A complementary attachment programme for operational emergency managers has been added for the 2005 season. The Chairman hoped this programme, designed to bring together representatives of a country's meteorological service and emergency management agency, would foster improved coordination. The RSMC Miami/WMO had already asked Permanent Representatives of Members of Regional Association IV and the directors of emergency management agencies to nominate candidates for the 2005 season.

2.5 Three meteorologists from the Mexican Air Force were stationed at the RSMC Miami during 2004. Cap. Jose Roberto Hernandez Lucero, Cap. Andres Calderon Fernandez, and Cap. Jose Miguel Ramirez Cuachayo coordinated timely clearances for hurricane surveillance and reconnaissance flights over Mexico during potential landfalling tropical cyclone events. Their efforts helped improve the overall efficiency of the Hurricane Warning Programme. The Chairman hoped this programme would continue in 2005.

2.6 The 2005 RA IV Workshop on Hurricane Forecasting and Warning was scheduled to take place at RSMC Miami from 11 to 23 April 2005. The workshop would be conducted in

English only. However, the Chairman strongly felt that offering the bilingual workshop is important to the Region's hurricane programme.

2.7 The Latin America/Caribbean Hurricane Awareness Tour (LA/CHAT) took place from 13 to 19 March 2005. The U.S. Air Force C-130 (H-model) hurricane hunter plane visited La Paz, Puerto Vallarta, Matamoros, and Cancun, Mexico, as well as the Turks and Caicos Islands and San Juan, Puerto Rico. The LA/CHAT successfully conveyed the importance of the team effort involved in the hurricane programme and the need for advance planning in high-risk communities. The LA/CHAT enhanced the visibility of the individual country weather forecasting and emergency management offices. Nearly 10,000 people toured the plane. A Hurricane Awareness Tour (HAT) took place along the U.S. coast of the Gulf of Mexico from 17 to 21 May 2004. Another HAT is expected to take place along the USA east coast from 2 to 6 May 2005.

2.8 Reconnaissance aircraft continue to play an important role in monitoring the track and intensity of tropical cyclones. U.S. Air Force Reconnaissance (USAFR) hurricane flights provide valuable meteorological data not available from other sources. During the 2004 season, the USAFR flew 105 missions, and the NOAA P-3 and NOAA jet flew 41 missions. The 41 NOAA missions included synoptic surveillance flights. Cooperation by all parties involved in obtaining over flight permission is greatly appreciated.

2.9 During the 2004 season, real-time radar imagery received via the Internet from Cuba and Mexico again proved extremely useful to the RSMC Miami. The Chairman encouraged all Members to make their radar imagery available in real-time, when practical.

2.10 The Member countries' surface and upper-air observations are 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 proved particularly valuable during hurricanes Frances and Jeanne. The RSMC Miami benefited from the renewed receipt of observations from Cuba. Additionally, the efforts by HAM radio operators during the hurricane events were invaluable.

2.11 The Chairman thanked the Members affected by tropical cyclones for the submission of their post-storm country reports. The timely submission of these reports is vital to the preparation of the RSMC Miami Tropical Cyclone Report.

2.12 Reconstruction plans proposed at the Caribbean Hurricane Reconstruction Meeting held in San Diego, California in January 2005 are underway in the Bahamas, Cayman Islands, Grenada, Honduras and Jamaica. The reconstruction is funded by U.S. Congressional hurricane supplemental funds. In addition, the supplemental funds would provide for the placement of six new buoys in the region, research and model improvements, facility and equipment repairs, Air Force radiometer data and upgrades to the NOAA G-IV.

2.13 The Chairman served as a panelist along with Dr Colin Depradine (CIMH) for the thematic session "Reducing Risks through Effective Early Warnings of Severe Weather Hazards" at the World Conference on Disaster Reduction held from 18 to 22 January 2005 in Kobe, Japan, where Dr José Rubiera (Cuba) also participated. He reported on the outcomes of the WMO TCP Expert Meeting on Effective Early Warnings of Tropical Cyclones, which he chaired.

2.14 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, eight projects have been approved for transition to operations.

2.15 The Chairman was pleased that 23 Members attended the American Meteorological Society's (AMS) 26th Conference on Hurricanes and Tropical Meteorology held in Miami Beach, Florida from 3 to 7 May 2004. Special thanks go to Dr Lixion Avila for his efforts in organizing and chairing that conference. In related AMS news, Dr Avila began serving as the Chairman of the AMS Tropical Committee from 2 February 2005.

2.16 The next International Workshop on Tropical Cyclones (IWTC-VI) is tentatively scheduled for 21 to 30 November 2006 in San José, Costa Rica. Lixion Avila continues to represent RA IV on the international organizing Committee.

2.17 Given that RSMC Miami issues tropical cyclone forecasts and coordinates watches and warnings for the entire North Atlantic Ocean, the Chairman appreciated WMO's efforts to ensure that the Azores and Cape Verde Islands fully benefit by providing current contact information, copies of the Operational Plan, and encouraging their participation in training and Hurricane Committee Meetings.

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

3.1 The Committee was pleased to note that within the framework of the International Strategy for Disaster Reduction (ISDR) and in the context of the Sustainable Development of Small Islands Developing States (SIDS), the TCP had in 2004 made special efforts to strengthen and improve the capabilities of National Meteorological and Hydrological Services (NMHSs) in the provision of improved tropical cyclone forecasts and effective warnings. Foremost among these are efforts in capacity building by providing assistance in the attachment of forecasters at the different Regional Specialized Meteorological Centres (RSMCs) during the cyclone season, attachment of storm surge/wave experts at the Indian Institute of Technology in Kharagpur, and the conduct of refresher training events to operational forecasters on tropical cyclone forecasting and warning such as the Workshop on Hurricane Forecasting and Warning which was held at the RSMC Miami-Hurricane Center from 13 to 24 April 2004.

3.2 The Committee observed that four hurricanes struck the Caribbean and the USA in August and September 2004, killing more than 3,000 people and causing damage worth billions of dollars. It was the first time that the USA had been hit by four destructive hurricanes in such rapid succession since 1950. While the loss figures have been high, it is important to stress that they would have been much higher without pre-disaster efforts, particularly early warnings. They contributed significantly to disaster preparedness, particularly in reducing loss of life and property. The TCP and the NMHSs placed specific emphasis on increased accuracy and timely dissemination of early warnings along with insuring effective response of the communities to this information through public training and education.

3.3 The Committee was informed that the TCP Programme in 2004 continued to encourage Members of the five tropical cyclone regional bodies to think more strategically and to share best warning practices between them which would be of assistance in their efforts to capitalize on growing research and development opportunities. In this respect, the TCP organized the Second Regional Technical Conference on Tropical Cyclones, Storm Surges and Floods (Brisbane, 1 to 3 July 2004), co-sponsored the International Conference on Storms (Brisbane, 5-9 July 2005) and provided assistance in organizing the Meeting of the Working Group on the Review of the Operations and Structure of the Typhoon Committee (Bangkok, 20 to 22 April 2004), Workshop on Living with Risk: Dealing with Typhoon-related Disasters as part of Integrated Water Resources Management (Seoul, 20 to 24 September 2004) and the series of roving lecture seminars on tropical cyclones arranged by the Committee's Typhoon Research Coordinating Group from 20 to 24 November 2004 in Beijing and from 25 to 27 November 2004 in Kuala Lumpur. In keeping with the scheme not to limit the technology information exchange services to electronic data accessible only through the Internet, the TCP had made available training materials and reports in CD-ROM which were distributed to Members.

3.4 The Committee urged the TCP to implement the following TCP-subprojects as soon as possible:

- No. 25 Study on the economic and social impacts of tropical cyclones;
- No. 26 Evaluation of tropical cyclone warning systems (their effectiveness and deficiencies).

3.5 The Committee requested WMO to organize a Workshop on Living with Risk: Dealing with Hurricane-related Disasters as part of Integrated Water Resources Management in Region IV.

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 2004 hurricane season in the Atlantic basin and in the eastern North Pacific was presented to the Committee by Lixion Avila, Hurricane Specialist of RSMC Miami.

RSMC Miami 2004 Atlantic Hurricane Season Summary

4.1.2 The 2004 Atlantic hurricane season was among the most devastating on record. This year's storms claimed over 3100 lives, the second largest toll in three decades; 60 of these occurred in the United States. The United States suffered a record USD 45 billion in property damage, enduring landfalls from five hurricanes (Charley, Frances, Gaston, Ivan, and Jeanne), and the eyewall passage of a sixth (Alex) that avoided landfall on the North Carolina Outer Banks by 10 miles. In addition, Bonnie, Hermine, and Matthew made landfall in the United States as tropical storms. Florida, the "sunshine state", became known as the "plywood state" after being battered by Charley, Frances, Ivan and Jeanne. The islands of the Caribbean were also hard hit. Charley struck Cuba as a major hurricane (winds of 111 m.p.h. or greater – category 3 or higher on the Saffir-Simpson Hurricane Scale). Ivan caused deaths and extensive destruction on Grenada, Jamaica, Grand Cayman, and Cuba, while Jeanne produced catastrophic flash floods in Haiti that killed thousands and left hundreds of thousands homeless.

4.1.3 Fifteen named storms developed in 2004, including Nicole, a subtropical storm. Nine of the named systems became hurricanes and, of these, six became major hurricanes. One additional tropical depression did not reach storm strength. These totals are considerably above the long-term (1944-2003) means of 10.2 named storms, 6.0 hurricanes, and 2.6 major hurricanes. August alone saw the formation of eight tropical storms, a new record for that month. The season also featured intense and long-lived hurricanes. Ivan, a category 5 storm, reached a minimum pressure of 910 mb, an intensity exceeded by only five other tropical cyclones in the Atlantic basin. In addition, Ivan was a major hurricane for a total of 10 days, a new record for one storm since reliable records began in 1944. In terms of "accumulated cyclone energy" (ACE, the sum of the squares of the maximum wind speed at six hour intervals), overall activity this year was over two and a half times the long-term mean.

4.1.4 The above-normal levels of activity in 2004 continued a trend that began in 1995 for greater numbers of storms. This appears to be due, in part, to sea-surface temperatures (SSTs) over the North Atlantic Ocean that have been considerably warmer during the past 10 years than during the preceding decade. In fact, 2004 was the second warmest year since 1948, as measured by SSTs between 10°N and 20°N in the tropical Atlantic Ocean and Caribbean Sea during the peak months of the hurricane season. Large-scale steering patterns in 2004, however, differed significantly from those occurring over much of the past decade, which had been characterized by a mid-level trough near the eastern coast of the United States that took many storms out to sea before they could make landfall. In contrast, persistent high pressure over the eastern United States and the western Atlantic during 2004 kept the season's storms on more westerly tracks. This steering current was coupled with lower than normal vertical wind shear over the Caribbean Sea and western Atlantic; this combination allowed hurricanes approaching the North American continent to keep much of their intensity. It remains to be seen whether these new large-scale patterns represent a one-year anomaly or something more ominous.

RSMC Miami 2004 Eastern Pacific Hurricane Season Summary

4.1.5 Tropical cyclone activity was below average in the eastern North Pacific in 2004. There were twelve named tropical cyclones; six of these became hurricanes. Three of the hurricanes reached category three or higher intensity on the Saffir-Simpson Hurricane Scale, far from land. The long-term averages for this basin are sixteen named tropical cyclones and nine hurricanes. In addition, there were three tropical depressions which remained at sea and one that affected Mexico. The genesis of most of the tropical cyclones was associated with westward-moving tropical waves.

4.1.6 The season was benign, with no reports of deaths or damage attributed to tropical cyclones during 2004. None of the cyclones made landfall as tropical storms or hurricanes. However, Javier reached Baja California as a tropical depression, and Tropical Storm Lester brushed the southwest coast of Mexico. Tropical Depression Sixteen-E, the last cyclone of the season, was a short-lived cyclone that developed about 315 miles south-southeast of Cabo San Lucas Mexico early on 25 October. The depression moved northward and crossed the extreme southeastern portion of the Sea of Cortez, before moving inland along the northwestern coast of Mexico midway between Guasave and Topolobampo on 26 October. Heavy rains fell along the coastal and mountain regions of west-central and northwestern Mexico causing some localized flooding and the mid-level moisture associated with the depression eventually spread northeastward over northern Mexico and into portions of the U.S. southern plains.

4.1.7 The detailed report on the 2004 hurricane season provided by the RSMC is given in Appendix III.

4.2 Reports on hurricanes, tropical storms, tropical disturbances and related flooding during 2004 (agenda item 4.2)

4.2.1 Many Member countries presented to the Committee PowerPoint slides or animations, detailed reports on the impact of the very active 2004 Atlantic hurricane season's tropical cyclones and other severe weather events such as floods, storm surges and tornadoes in their respective countries.

4.2.2 The Committee invited WMO in consultation with the host country to reproduce their PowerPoint presentations on CD-ROM and to distribute it to the participants before their departure from San José.

4.2.3 The Committee was informed by the representative of the USA that the 2004 Atlantic hurricane season was among the most devastating on record. The USA suffered a record USD 45 billion in property damage, enduring landfalls from five hurricanes (Charley, Frances, Gaston, Ivan and Jeanne) and the eyewall passage of a sixth (Alex) that avoided landfall on the North Carolina Outer Banks by 10 miles. In addition, Bonnie, Hermine, and Matthew made landfall in the USA as tropical storms. This year's storms claimed 60 lives in the USA.

4.2.4 The Committee was informed by the representative of Grenada that in 2004, Grenada was affected by three tropical cyclones of increasing magnitude. On 9 August, Tropical Depression # 3, which went on to become Hurricane Charley, formed close to the Island. Less than one week after, on 15 August, Tropical Storm Earl was next to affect Grenada. Then on 7 September came Hurricane Ivan. Public responses to advisories on TD # 3 and TS Earl were poor, and although the responses were marginally better for the approach of Hurricane Ivan, much work has to be done in this area. Ivan resulted in widespread damages and destruction to Grenada. About 90% of the housing were damaged or totally destroyed. The agricultural sector suffered badly, while education, tourism, health, manufacturing and utility suffered at various levels all totalling about USD 1.1 billion. Unfortunately, the loss of lives numbered 39 persons, attributed directly to Ivan's passage and may very well reflect the low level of public response to the advisories and warnings. Deaths in the post Ivan period were more notable among the senior citizens as the population tried to cope with Ivan's devastation. Ivan's center passed about 5 miles off Grenada's southern tip. Sustained winds of 120 mph were experienced, with a maximum gust of 133 mph and rainfall amounts of 133.7 mm, recorded at the Point Salines International Airport.

4.2.5 The Committee was informed by the representative of the Bahamas that the Bahamas Archipelago was affected by two cyclones, one of which also affected the Turks and Caicos Islands. Frances, a major hurricane, affected the entire Bahamas and the Turks and Caicos Islands with its centre passing near the Turks and Caicos Islands and directly over San Salvador. Within three weeks after Frances moved away from the islands of the northern Bahamas, the center of Jeanne, another major hurricane, moved over northern islands. Two deaths occurred in the Bahamas as a result of Frances, one in New Providence and the other in Freeport, Grand Bahama. Also civil infrastructure, both public and private, on many islands was severely impacted.

4.2.6 The representative of Jamaica reported to the Committee that Jamaica was impacted twice during the 2004 hurricane season; first by Hurricane Charley on 11 and 12 August and then Hurricane Ivan from 10 to 12 September. Charley passed approximately 150 kilometers south of Kingston before skirting the south-western coastline where it caused significant rain and wind damage leaving in its wake one death and USD 4.1 million in damage. Ivan with Category 4 winds, followed a month later in September with greater fury as its centre came within 30 kilometers of the island´s south coast. Communities across Jamaica felt the full brunt of hurricane force winds, torrential rainfall, numerous landslides and devastating storm surges and floods, leaving tales of destruction behind. In the wake of Hurricane Ivan, 17 lives were lost and damage was estimated at USD 575 million.

4.2.7 The representative of Cayman Islands informed the Committee of the impacts of Hurricane Ivan over the Cayman Islands. It was noted that Ivan became a slow moving system as it entered the Cayman area and came within 21 miles of the south coast of Grand Cayman as a strong Category 4 hurricane. As a result of this slower forward motion, Grand Cayman remained under the influence of the system from the afternoon of 11 September through the morning of 13 September 2004. This caused a storm surge of around 8–10 feet as well as widespread damage and destruction to property in the order of USD 3.5 billion, as reported by the UN Economic Commission for Latin America and the Caribbean (ECLAC). However, excellent cooperation between the media, the Meteorological Service and the National Hurricane Committee of the Cayman led to frequent and widespread dissemination of bulletins and warnings to the public from one credible source. A consequence of this was that many people were evacuated from the island before the arrival of the hurricane, and many others sought safe shelter early. Subsequently, there were only two confirmed fatalities directly attributed to the hurricane.

4.2.8 The Committee was informed by the representative of Cuba that two deadly major hurricanes hit Cuba this past season. Charley had 190 km/h maximum sustained winds and gusts up to 215 km/h when it made landfall in western Cuba on 13 August. There was great destruction to communication and electric infrastructure, housing and agriculture, estimated at USD 923 million, with four fatalities. Just one month after, powerful Category 5 Hurricane Ivan hit the westernmost part of Cuba. There was a great preparation for the storm well before hand. More than 2 million people were evacuated, 60% of them in relatives' homes. Material losses were USD 1.2 billion, but there were no fatalities. Television and radio were used very efficiently to prepare people and to give them forecasts and advisories directly from the Cuban National Forecasting Centre. The presence of Cuban President Fidel Castro in the Forecasting Centre during Charley, as well as in several special TV programs during Ivan's threat was very important.

4.2.9 The Committee was informed by the representative of the Dominican Republic that although Hurricane Jeanne only reached Category 1 status during the passage over the Dominican Republic, it caused torrential rainfall, very intense winds, major floods and river flooding, collapse of bridges, roads cut off, damage to agriculture, mud slides in outlying parts of towns, interrupted telephone services, power cuts and hundreds of homeless as well as 23 deaths. According to the ECLAC, the passage of Hurricane Jeanne caused losses equivalent to USD 270 million - 1.7% of the country's gross domestic product (GDP).

4.2.10 The representative of Barbados reported to the Committee that tropical cyclones threatened Barbados from early August to the first week in September. Charley originated from a tropical wave which developed into a depression on 9 August, while located few hundred miles east of Barbados, and briefly threatened the Island. On 13 August, TD # 5 formed from a vigorous tropical wave and evolved into a short-lived tropical storm 'Earl' on 14 August. Ivan, a long-lived and devastating major hurricane, represented the first significant threat to Barbados during the first week of September. It impacted the Island on 7 September with strong tropical storm force winds and inflicted a few million dollars in structural and other damage.

4.2.11 The Committee was informed by the representative of Trinidad and Tobago that the 2004 Atlantic hurricane season produced two tropical cyclones, which passed near Trinidad and Tobago. The first was Tropical Storm Earl, which passed to the north of Tobago creating wind gusts of 33 kt but no significant damage. Hurricane Ivan produced tropical storm strength winds on the windward side of Tobago and gusts of 40 kt on the leeward side. One fatality occurred in Tobago due to Ivan where there were losses in agriculture and forestry. Civil infrastructure was impacted, through the strong winds and rainfall, which caused mudslides and landslides. Tobago suffered USD 4.9 million in damages due to the passage of Ivan. Twenty-two persons were rendered homeless and one thousand persons were directly affected.

4.2.12 The Chairman read a report submitted by the representative of Haiti that outlined two disastrous events that occurred in 2004. The first described a rainfall event that produced 300 mm of rain with peaks of 600 mm in some areas, resulting in severe floods with 1,261 deaths and 1,414 persons missing. The second event described the effects of the heavy rainfall from Tropical Depression Jeanne 18 September. The depression produced about 300 mm of rain in 36 hours which resulted in a severe flood in the city of Gonaives and caused the death of 1,870 persons with 1,184 reported missing. The Meteorological Service was unable to respond and adequately warn the inhabitants on both occasions.

4.2.13 The detailed reports on the 2004 hurricane season provided by Member countries are given in Appendix IV.

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

5.1 The Committee designated Mr Tyrone Sutherland (BCT) as rapporteur on this agenda item. The meeting considered several matters raised by Committee members or Members of RA IV and relevant partner organizations that has an impact on the effectiveness of the Hurricane Warning System.

5.2 In this regard, the representative of Colombia suggested that the 2004 passage of ***Hurricane Ivan*** across the Caribbean Sea highlighted the lack of real-time wind data in the coastal area of the southern Caribbean Sea, which made it difficult to properly assess the threat posed by the wind. Colombia felt that the entire network of surface stations across the southern Caribbean Sea needed to be strengthened to provide more data, especially wind, to numerical models that would assist in the assessment of the possible effects of climate change on tropical systems across the southern part of the Region. The meeting felt that, as a first measure, efforts should be made to ensure that stations already listed in the Regional Basic Synoptic Network (RBSN) were all operational. The (outgoing) Chairman of the RA IV Working Group on the Implementation of the World Weather Watch assured the Committee that concerns in these matter would be considered by the Working Group, along with the regional requirements for the Global Climate Observing System (GCOS).

5.3 At the same time, the Chairman of the Committee reiterated the accepted view among hurricane scientists that climate change was not the cause of existing trends in hurricane activity and that the long-term implications of climate change on tropical cyclones were still a matter for the research community.

5.4 The Committee discussed the request by Colombia for a formal mechanism for the real-time exchange of national advisories, watches and warnings between neighbouring Meteorological Services, to augment the information provided by RSMC Miami. It was felt that this could be adequately achieved by accessing such advisories, watches and warnings on national websites listed in Attachment 8E of the RA IV Hurricane Operational Plan, as well as the regional weather portal hosted by the Meteorological Service of the Netherlands Antilles and Aruba at **www.caribweather.net**.

5.5 There was some discussion on the difficulties faced with Automatic Weather Observing Stations (AWOS) because power outages due to winds usually occurred well before the limits of the sensors on the stations were reached. The Committee stressed the need to ensure that all AWOSs, particularly those in coastal areas, had adequate back-up power supplies.

5.6 In addition, the Committee noted that many instruments were not robust enough for the tropics and that several were not capable of measuring or recording the extremes in hurricane conditions, such as very high wind peaks and very low pressures. The Committee recommended the use of more robust instruments and requested that the WMO Commission for Instruments and Methods of Observations (CIMO) be asked to look into instrumentation standards for the measurement and recording of extreme values in tropical cyclones.

5.7 The Hurricane Committee recalled that the RSMC Miami also served as the ICAO-designated Tropical Cyclone Advisory Centre (TCAC) for the coordination and provision of tropical cyclones advisories in the Tropical Atlantic Ocean, Caribbean Sea, Gulf of Mexico and the north Pacific Ocean east of 140°W. These TCAC advisories are essential for the safety and efficiency of international civil aviation. The ICAO expressed its appreciation for the efforts of the TCAC Miami to improve aviation safety in the Caribbean/South America (CAR/SAM) Region and indicated its pleasure with the new tropical cyclone advisory product implemented by the TCAC Miami in 2004. The ICAO requested the TCAC to ensure the routing of TC advisories to Meteorological Watch Offices (MWOs), OPMET data banks and Washington and London World Area Forecast Centres for uplink to the ISCS and SADIS broadcasts respectively. The Meteorological Watch Offices to which Tropical Cyclone advisory information is to be sent by TCAC Miami are shown in Appendix V.

5.8 In addition, the ICAO informed the Committee and the TCAC Miami that the International Air Transport Association (IATA) has stated a requirement for the inclusion of (i) frequent CB and (ii) the horizontal extent of gale-force winds in tropical cyclone advisories in graphical format. In this regard, it was expected that a proposal to meet this specific user requirement would be presented at the forthcoming WMO TC Programme Coordination Meeting, to be convened in December 2005.

5.9 Météo-France (MF) informed the Hurricane Committee of a project involving MF and local authorities in the French West Indies (FWI) to improve the cyclone warning system at the local level. MF was particularly interested in getting information on the technical and administrative roles of the various eastern Caribbean National Meteorological Services within their local warning system beyond the issuance of warnings, such as in the decision-making process for evacuations or closure of facilities. The Committee recommended that MF request information on local plans directly from individual NMSs and/or the Caribbean Disaster Emergency Response Agency (CDERA).

5.10 MF enquired whether it was possible or not for the RSMC/NHC to make the forecast hurricane tracks from all the models it used available to the NMSs, such as on the NHC website. The RSMC indicated that information on most models used was already available on several websites, some of which could be accessed through the NHC website. In addition, the RSMC would consult with the US Navy on the possibility of the Navy making its similar information available. The RSMC informed the Committee that the NHC website had a new page providing track and intensity model verification. The Committee welcomed the information that MF was studying the possibility of making available different products, including forecast tracks, from different models used by MF. However, the Committee noted that the verification aspects of these models should also be made available.

5.11 The Chairman informed the Committee that the RSMC would introduce ***experimental graphical (web) and text products*** providing one- to five-day probabilities for 34, 50 and 64 kt wind speed thresholds during the 2005 hurricane season. The text products would provide wind probabilities at selected locations on the Atlantic, Caribbean and Eastern Pacific coasts. The locations in the Atlantic and Caribbean that appeared in the existing “Strike Probability” (WTNT71-75) product would be used in the experimental product. The RSMC requested the countries with Pacific coasts, namely Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama, to identify key country locations by 15 April 2005 for inclusion in the experimental product. The Committee was informed that Mexico had already provided its information.

5.12 As was normal during every session, the Hurricane Committee reviewed the published names of the tropical cyclones used in both the Atlantic and Pacific Basins, in case there was any need for changes. This year, the Committee was requested to retire the names Charley, Frances, Jeanne and Ivan from the Atlantic list because of the damage and deaths associated with those hurricanes in 2004. The representative of Mexico raised questions on the methods used by the Committee in selecting the language base of the names chosen, indicating the desire for a more even distribution of English, Spanish and French-based names. The Committee agreed that, while it would take this request into account as names were gradually replaced in the future, most of the names routinely chosen actually had a multi-language base and were easily used in any language. At the same time, it agreed that names should be short and easy to pronounce in any language.

5.13 In this connection, the Committee decided to:

- replace Charley with **Colin**;
- replace Frances with **Fiona**;
- replace Ivan with **Igor**; and,
- replace Jeanne with **Julia**.

These new names would be submitted as part of the Hurricane Operational Plan to the next session of the Region Association IV for its approval (see paragraphs 6.3 and 6.4 below). They would appear in the rotating list of names in 2010.

5.14 The Hurricane Committee agreed that, while no warning system is ever perfect, the tropical cyclone warning system set up by the Committee in the Atlantic and Eastern Pacific Basins is widely considered the best operated in any tropical ocean basin in the world. The RA IV Hurricane Committee's system is based on continuous improvements in systems and technologies, hurricane sciences, computer capabilities and forecast error reduction, continuous upgrading of regional human resources capabilities in hurricane forecasting and warnings, the important use and improvement of capabilities in hurricane aircraft reconnaissance, the vital collaboration between forecast and warning centres in the region and the RSMC, and improving warning dissemination capabilities at the local level. Statistics have clearly shown that, while damage to property cannot be avoided, there has been a major decrease in the loss of life in RA IV as a result of tropical storms, hurricanes and other severe weather.

5.15 With the above in mind, the Committee expressed great surprise and extreme disappointment that while the Caribbean Disaster Emergency Response Agency (CDERA), one of the primary agencies of its type in the Region, shares similar sentiments on the effectiveness of the RA IV hurricane warning system, it would hold the view that "Despite the significant reduction in loss of life from hurricane events, there is a general perception of a lack of confidence in our meteorological services". This view was expressed in an address by CDERA to the United Nations' World Conference on Disaster Reduction that took place in Japan in January 2005. In reviewing the CDERA address, the Committee found it strange that CDERA would expect a level of accuracy in hurricane warnings for very small islands that has not been attained anywhere else in the world. It agreed that the CDERA statement, which was posted on its website"www.cdera.org" could have very negative implications for the programmes of some National Meteorological Services. The Committee therefore requested that its concern on the matter be brought to the attention of the WMO Regional Association IV for North America, Central America and the Caribbean, and that the Secretary-General be requested to take up this matter with CDERA and the Caribbean Community (CARICOM).

5.16 The Hurricane Committee, in fact, was particularly pleased with the successful implementation of the Region's Hurricane Operational Plan during 2004. It noted that, in all cases, warnings were very timely and widely distributed to the public and other special users. However, the Committee noted that there were particular weaknesses in the public response to warnings in a number of states that had not been affected by hurricanes for a long time. It also noted that, in the case of Haiti, the enormous loss of life was due to local factors that nullified the effects of early warnings. Notwithstanding the recent success stories evident within the regional hurricane warning process, there exists the need for continuous educational and awareness programmes, including mitigation, within the Region, undertaken as a team effort of all relevant agencies, so as to further enhance public understanding and response to warnings issued.

5.17 In this connection, the Committee noted that some of the programmes and exercises to train emergency managers undertaken in the Region by the US military Southern Command might be too ambitious. It was felt that a greater meteorological input was needed in the design of their exercises. The Committee noted that these matters were consistent with the Disaster Reduction and Preparedness portions of its Technical Plan.

5.18 The Committee agreed that one of the very successful and important activities that contributes to public awareness is the regular Latin America/Caribbean Hurricane Awareness Tour (LA/CHAT) undertaken by the U.S. Air Force in collaboration with the RSMC Miami. The LA/CHAT successfully conveys the importance of the team effort involved in the hurricane programme and the need for advanced planning in high-risk communities. The LA/CHAT enhances the visibility of the individual country weather forecasting and emergency management offices. The Committee expressed its sincere thanks to the authorities in the USA for undertaking this important activity and urged that the programme receive their continuing support. The Committee urged the RA IV president and individual RA IV Members to write letters of appreciation to the Permanent Representative of the USA with WMO.

5.19 There was considerable discussion on the BACK-UP arrangements between countries of the Region for Watches and Warnings, as provided for in the Operational Plan (see Chapter 2). While the arrangements have been in place for some time, a true test of the system occurred in 2004 when Jamaica successfully assumed responsibility for the Cayman Islands as a result of damage suffered by its Forecast and Warning Office during the passage of Hurricane Ivan. This support occurred despite the fact that Hurricane Ivan also affected Jamaica. The meeting noted the importance of the use of satellite telephones during this period when most telecommunication infrastructure had been severely damaged. It, therefore, **strongly recommended** that all Forecast and Warning offices, at the first instance, should be equipped with such telephones. The Committee noted that back-up arrangements were not easy to implement in every case or in every aspect. However, it **further recommended** that countries with back-up arrangements should exchange, on a bilateral basis, information on watches, warnings and agreed-upon essential products to be produced under the circumstances, and the message and telecommunication details for distribution of these products. It noted that these essential products should always include the Terminal Forecasts for main airports. It was agreed that the Operational Plan be amended to reflect that these arrangements would include agreed-upon essential products.

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

6.1 Under this agenda item, the Committee designated Mr Carlos Fuller (representative of English-speaking members) and Dr José Rubiera (representative of Spanish-speaking members) to serve as rapporteurs.

6.2 The Committee reviewed the RA IV Hurricane Operational Plan, taking into account changes and additions that came out from the other agenda items.

6.3 As is the normal practice, the Committee retired names of cyclones of significant strength or impact during the previous season. On the Atlantic list, “Charley, Frances, Ivan and

Jeanne" were retired and replaced by "Colin, Fiona, Igor and Julia", respectively (see paragraph 5.13 above).

6.4 The Committee made amendments and changes to the plan. It recommended to XIV-RA IV the approval of the amendments to the text of the plan. The Committee urged WMO that these amendments and changes made to the attachments to the plan should be published in a new 2005 edition in English and Spanish, as soon as possible. The Committee thanked France for its continuing translation of the Operational Plan into French and for providing it to Haiti.

7. REVIEW OF THE COMMITTE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2005 AND BEYOND (Agenda item 7)

7.1 For the agenda item, Carlos Fuller and José Rubiera were again designated to serve as rapporteurs.

7.2 The Committee noted that the RA IV Hurricane Committee's Technical Plan and its Implementation Programme adopted by Resolution 8 (X-RA IV) and retained by XIII-RA IV, forms the basis for the long-term programme of the Committee's activities. The Technical Plan by its nature calls for regular updating as various parts of which have been implemented by the Members concerned and the requirements would be revised in the light of new developments. While the plan consists of five components, consideration of more detailed aspects of the meteorological component and the main discussions on the topics of hydrology, training and research would take place at the XIV-RA IV (San José, 5 April (p.m.) to 13 April 2005).

Disaster Prevention and Preparedness Component

7.3 The representative of ISDR Secretariat gave a briefing on the recent activities related to disaster risk reduction, focusing on the World Conference on Disaster Reduction (WCDR), its major outcome and follow-up, as well as on the recent activities related to early warning. The world conference, which took place in Japan from 18-22 January 2005, was attended by more than 4,000 participants, including representatives from 168 countries, 78 UN Specialized Agencies and other organizations or agencies, 161 NGOs and more than 500 journalists. Discussions at the WCDR resulted in two negotiated documents: a program outcome document entitled "Building the resilience of nations and communities to disasters: Hyogo Framework for Action 2005-2015", and "Hyogo Declaration". The delegates also adopted a common statement on the Special Session on the Indian Ocean Tsunami. The Hyogo Framework for Action (HFA) outlines the five priority areas of action as follows:

(1) ensuring that disaster risk reduction is a national and local priority with a strong institutional basis for implementation;

(2) identifying, assessing and monitoring disaster risks and enhancing early warning;

(3) using knowledge, innovation and education to build a culture of safety and resilience at all levels;

(4) reducing underlying risk factors; and

(5) strengthening disaster preparedness for effective response at all levels. As one of the immediate follow-up actions to WCDR, the ISDR Secretariat is currently preparing a matrix of roles and initiatives for the implementation of the HFA, as well

as the initial set of benchmarks and indicators, which will be soon shared with other stakeholders at international, regional and national levels.

7.4 The ISDR representative also informed the Committee about the recently launched Platform for Promotion of the Early Warning, based in Bonn (Germany), and coordinated by the ISDR Secretariat (www.unisdr.org/ppew), as well as on the international early warning programme, sponsored by several leading UN Agencies. The ISDR representative ended her presentation by reminding the importance of information sharing, public awareness and educational activities in order to achieve the culture of prevention and resilience. More information on the above initiatives is available online at: www.unisdr.org, www.eird.org

7.5 On behalf of the Office for Coordination of Humanitarian Affairs (OCHA), Ms Palm briefed the Committee on the roles and functions of the OCHA Office in Panama.

Reducing risks through effective early warnings of tropical cyclones

7.6 The Committee was informed that the TCP organized the Expert Meeting on Effective Early Warnings of Tropical Cyclones in Kobe, Japan on 17 and 18 January 2005, in association with the World Conference on Disaster Reduction (WCDR) (Kobe, 18 to 22 January 2005). Ten tropical cyclone experts from all tropical cyclone prone areas were invited to attend the meeting. From Region IV, Colin Depradine (CIMH), Max Mayfield (Chairman of Hurricane Committee) and José Rubiera (vice-Chairman of Hurricane Committee) were invited to attend the meeting.

7.7 The meeting featured a series of presentations which dealt with most aspects related to tropical cyclones and associated storm surges, allowing in-depth analysis and experience sharing, as well as updates on technical advances in probabilistic forecasts and effective early warning.

7.8 "Suggested targets and indicators to measure accomplishments" towards tropical cyclone disaster reduction, which had been provided by the meeting, were well received at the thematic session entitled "Reducing Risks Through Effective Early Warnings of Severe Weather Hazards" under Cluster 2 "Risk Identification, Assessment, Monitoring and Early Warning" of the Thematic segment of the WCDR (see paragraph 2.13 above).

7.9 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-sixth session of the Committee.

7.10 The Committee recommended to the XIV-RA IV the approval of the updated RA IV Hurricane Committee's Technical Plan and its Implementation Programme, which is given in Appendix VI.

8. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE COMMITTEE'S TECHNICAL PLAN AND STRENGTHENING 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-sixth 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 (North, Central America and the Caribbean, (NCAC)), with the support of the WMO Subregional Office in Costa Rica 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. The project benefited CMO countries, Cuba, Dominican Republic and Haiti. The main achievements include the upgrade of the ISCS workstations for meteorological telecommunications, Twenty-nine automatic weather stations installed and operational in 12 countries, as well as installation of conventional meteorological equipment in eleven recipient countries. Three more students completed the BIP-MT course in operational forecasters at the University of Costa Rica. Short training courses on TV /media presentations, operation and use of AWS, and data rescue were organized. A decision-makers seminar for participating countries was also organized in Barbados in May 2004.

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 USD 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 2005 in three selected countries. The Finnish Meteorological Institute and the Caribbean Meteorological Organization are to collaborate with WMO in the implementation of the project.

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 WMO continued to assist Mexico in the implementation of the large scale Water Resources Management Project (PROMMA). A total of 31 international and 42 national consultants carried out some 80 missions to cover the areas of meteorology, operational 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 will take place in Mexico City in March 2006.

Regional activities

8.7 The Committee was informed that the following Regional activities were carried out during 2004:

a) The second meeting of Directors of NMHSs of Ibero-American countries was held at the Training Center of the Spanish Cooperation in Cartagena de Indias, Colombia from 7 to 9 July 2004. The main result of the meeting was the approval of an Iberoamerican programme of cooperation among NMHS of the Region. The meeting was organized by the National Meteorological Institute of Spain and co-sponsored by WMO.

b) In RA IV WMO continued to collaborate with the various economic and technical organizations in the development and implementation of meteorology programmes and projects. These included the Association of Caribbean States (ACS) who chairs the Supervisory Board of the SIDS-Caribbean Project, CARICOM, SICA, CRRH, CMO and CEPREDENAC.

c) The radar networking system project supported by the European Union is being implemented under the coordination of the CMO. The project will benefit the Caribbean region in the provision of early warnings on hurricanes and severe weather.

8.8 The Committee noted that the RA IV Working Group on Hydrology (WGH) strongly endorsed CARIB-HYCOS. It noted that the island component of the project had been initiated with funding provided by France. The WMO Secretariat would seek the endorsement of governmental bodies for the continental component.

Assistance to NMHS

8.9 The Committee was informed that assistance was provided to Haiti and Dominican Republic following the floods that affected both countries in May 2004. A WMO mission was organized in early June to identify the requirements. Another mission to Haiti with the participation of UNDP, IDB, Météo-France and WMO took place in January 2005 to prepare a project proposal for the development and establishment of an early warning system to prevent floods in Haiti, which would be funded by the IDB.

8.10 The Committee was also informed that WMO organized missions to Guatemala, Panama, Mexico and Dominican Republic aimed at assisting the NMHS of these countries in the preparation and follow-up of projects for the development and modernization of meteorological and hydrological observing networks. These would enhance the capability of NMHS in the provision of information for the prevention of natural disasters as well as other type of weather and climate information for the various socioeconomic sectors.

VCP projects

8.11 In 2004, one VCP project request was submitted by Costa Rica for the provision of upper-air consumables (GPS radiosondes and balloons), which was supported by USA under funding from the US Climate Change Research Initiative for the enhancement of global climate atmosphere observing systems. The VCP projects for the replacement of the RA IV RMTN workstation (TE/2/3/1) by providing WAFS RA IV RMTN workstation with the installation and training for Bahamas; Belize; Colombia; Costa Rica; El Salvador; Guatemala; Honduras; Netherlands Antilles and Aruba; Nicaragua; and Panama were completed during 2003-2004.

8.12 In spite of the sufficiently number of support obtained during 2000-2004, nine valid projects have not yet received funding support as of 31 January 2005. The list of VCP projects for RA IV Hurricane Committee Members is given in Appendix VII.

8.13 During 2004, 10 person months of fellowships were awarded within the framework of the VCP.

9. OTHER MATTERS (Agenda item 9)

9.1 The Hurricane Committee discussed the fact that the WMO Tropical Cyclone Programme (TCP) covers six tropical cyclone basins around the world and serves five tropical cyclone bodies, namely, the RA I Tropical Cyclone Committee, the WMO/ESCAP Panel on Tropical Cyclones, the ESCAP/WMO Typhoon Committee, the RA IV Hurricane Committee and the RA V Tropical Cyclone Committee. The Committee felt that, in view of the vitally important role of the TCP globally, the TCP Division in the WMO Secretariat needed to be at full strength to effectively manage the work of all these tropical cyclone bodies. With the imminent retirement of the Chief of the TCP, the Committee strongly recommended that the XIV-RA IV urge the Secretary-General to expeditiously fill the post of Chief of TCP.

9.2 In addition, the Committee expressed its concern that the funding for RA IV activities that had been approved by Fourteenth WMO Congress, such as the 2005 and 2007 sessions of the Hurricane Committee, appeared not to have been appropriately allocated for the proper organization and realization of these events. In this regard, the Committee requested the XIV RA IV to urge the Executive Council (Geneva, 20 June to 1 July 2005) to ensure:

(a) Full financial support to the annual session of the Hurricane Committee in 2007;

(b) Holding of the 2007 Workshop on Hurricane Forecasting and Warning at the RSMC Miami – Hurricane Center, with an interpretation service in English and Spanish.

9.3 Some Committee members raised the fact that there has not been any scientific experiment in the Tropical Atlantic basin relating to hurricanes for a very long time. The Committee was urged to give this matter some thought over the next year for discussion at the next session. If considered feasible and desirable, the Committee could then initiate actions with the WMO Executive Council in 2006. The Committee Chairman indicated that, as a start, he would invite some experts to the next session of the Committee to discuss specific on-going experiments or projects of interest to the Region, such as THORPEX and CAMEX.

9.4 The Committee concurred with a recommendation of the Working Group on the Implementation of the World Weather Watch in RA IV that it should meet every two years, and those meetings should be in conjunction with and just before the corresponding session of the Hurricane Committee. However, the Committee felt that, while both groups had several common experts, all core members of the WWW group should participate.

9.5 The English-speaking vice-Chairman of the Hurricane Committee, Mr Carlos Fuller, informed the Committee that he would relinquish this role at the end of this 2005 session. The Committee expressed its thanks to Mr Fuller for his outstanding service over the last 12 years and accepted the nomination of Mr Patrick Jeremiah (Antigua and Barbuda) as the next English-speaking vice-Chairman, to be submitted along with the names of the existing Chairman and Spanish-speaking vice-Chairman, to the fourteenth session of the Regional Association for approval.

9.6 The Committee expressed its sincere thanks to several participants who have contributed to the work of the Committee over the years and who will be retiring or moving on to other duties in the near future. This included, in particular, Mr Katsuhiro Abe of the WMO/TCP, Mr José Duquela and Mr José Placido Cabrera of the Dominican Republic Meteorological Service, Dr Colin Depradine, Principal of the Caribbean Institute for Meteorology and Hydrology (RMTC-Barbados), and Mr Guillermo Vega of ICAO. The Committee also thanked its specially-invited expert, Mr John Peters of Grenada, for his valuable participation in the session.

10. SCIENTIFIC LECTURES AND DISCUSSIONS (Agenda item 9)

10.1 The following scientific lectures were presented during the session:

- Experimental Tropical Cyclone Probabilistic Wind Products, by Dr Lixion Avila (USA);

- Atlantic Subtropical Cyclones, by Mr Mark Guishard (UK);

- The use of TV in disaster prevention, by Dr José Rubiera (Cuba).

10.2 The Committee thanked the lecturers for their excellent presentations which were followed by lively discussions.

11. DATE AND PLACE OF THE TWENTY-EIGHTH SESSION (Agenda item 11)

11.1 The USA offered to host the twenty-eighth session of the RA IV Hurricane Committee in San Juan, Puerto Rico, in conjunction with a Caribbean Hurricane Conference and possibly with a Meeting of the Working Group on Planning and Implementation of the WWW in Region IV, which might be held in April/May 2006. The exact dates and venue of the three events would be decided after consultations among WMO, the President of RA IV and the host country, as well as the Puerto Rico Weather Service Forecast Office.

11.2 The Committee, in welcoming the information and accepting with pleasure this offer, expressed its warm appreciation to the Government of the USA.

11.3 The representative of the Netherlands Antilles and Aruba informed the Committee that his county would like to host the twenty-ninth session in 2007 in Curaçao.

12. CLOSURE OF THE SESSION (Agenda item 12)

The report of the twenty-seventh session of the Committee was adopted at its final meeting at 1150 hours on 5 April 2005.

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 2004

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 2005 AND BEYOND

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RSMC MIAMI 2004 ATLANTIC AND EASTERN NORTH PACIFIC HURRICANE SEASON SUMMARY

(Submitted by the RSMC Miami – Hurricane Center, USA)

ATLANTIC

The 2004 Atlantic hurricane season was among the most devastating on record. This year's storms claimed over 3100 lives, the second largest toll in three decades; 60 of these occurred in the United States. The United States suffered a record $45 billion in property damage, enduring landfalls from five hurricanes (Charley, Frances, Gaston, Ivan, and Jeanne), and the eyewall passage of a sixth (Alex) that avoided landfall on the North Carolina Outer Banks by 10 miles. In addition, Bonnie, Hermine, and Matthew made landfall in the United States as tropical storms. Florida, the "sunshine state", became known as the plywood state after being battered by Charley, Frances, Ivan and Jeanne. The islands of the Caribbean were also hard hit. Charley struck Cuba as a major hurricane (winds of 111 m.p.h. or greater – category 3 or higher on the Saffir-Simpson Hurricane Scale). Ivan caused extensive destruction on Grenada, Jamaica, and Grand Cayman, while Jeanne produced catastrophic flash floods in Haiti that killed thousands and left hundreds of thousands homeless.

Fifteen named storms developed in 2004, including Nicole, a subtropical storm. Nine of the named systems became hurricanes and, of these, six became major hurricanes. One additional tropical depression did not reach storm strength. These totals are considerably above the long-term (1944-2003) means of 10.2 named storms, 6.0 hurricanes, and 2.6 major hurricanes. August alone saw the formation of eight tropical storms, a new record for that month. The season also featured intense and long-lived hurricanes. Ivan, a category 5 storm, reached a minimum pressure of 910 mb, an intensity exceeded by only five other tropical cyclones in the Atlantic basin. In addition, Ivan was a major hurricane for a total of 10 days, a new record for one storm since reliable records began in 1944. In terms of "accumulated cyclone energy" (ACE, the sum of the squares of the maximum wind speed at six hour intervals), overall activity this year was over two and a half times the long-term mean.

The above-normal levels of activity in 2004 continued a tendency that began in 1995 for greater numbers of storms. This appears to be due, in part, to sea-surface temperatures (SSTs) over the North Atlantic Ocean that have been considerably warmer during the past 10 years than during the preceding decade. In fact, 2004 was the second warmest year since 1948, as measured by SSTs between 10° and 20°N in the tropical Atlantic Ocean and Caribbean Sea during the peak months of the hurricane season. Large-scale steering patterns in 2004, however, differed significantly from those occurring over much of the past decade, which had been characterized by a mid-level trough near the eastern coast of the United States that took many storms out to sea before they could make landfall. In contrast, persistent high pressure over the eastern United States and the western Atlantic during 2004 kept the season's storms on more westerly tracks. This steering current was coupled with lower than normal vertical wind shear over the Caribbean Sea and western Atlantic; this combination allowed hurricanes approaching the North American continent to keep much of their intensity. It remains to be seen whether these new large-scale patterns represent a one-year anomaly or something more ominous.

In the cyclone summaries given below, all dates are based on Universal Coordinated Time, although local time is implied with expressions such as "afternoon", "mid-day", etc. Distances are given in statute miles.

Hurricane Alex

Alex developed out of a broad area of low pressure that formed near the central Bahamas on July 30. Thunderstorm activity with the low gradually became better organized and the system became a tropical depression on the 31st about 200 miles off the northeast Florida coast. Drifting erratically, the depression strengthened to a tropical storm the following day when northeasterly shear over the cyclone began to relax. Alex started to move northeastward early on August 2, slowly approaching the coastline of the Carolinas over the next 36 hours. Alex strengthened, becoming a hurricane on the 3rd when it was centered about 75 miles south-southeast of Cape Fear. Aided by warm Gulf Stream waters and light shear, Alex continued to strengthen during the day as it neared the North Carolina Outer Banks. Alex made its closest approach to land near midday, with its center located about 10 miles southeast of Cape Hatteras, while the western eyewall of the hurricane raked the Outer Banks with sustained category 1 hurricane force winds. During this close approach the hurricane's stronger category 2 winds remained just offshore. After passing the Outer Banks, Alex turned away from land and accelerated, becoming a major hurricane on the 5th about 445 miles south-southwest of Halifax, Nova Scotia with 120 m.p.h. maximum winds. Only Hurricane Ellen of 1973 attained major hurricane status at a higher latitude. Alex then proceeded to weaken over colder waters and lost tropical characteristics on the 6th.

In addition to hurricane force winds, the Outer Banks experienced a storm surge of about 6 feet and rainfall in excess of 7 inches. One person died in rip currents associated with the storm. Damage is estimated to be less than $5 million.

Tropical Storm Bonnie

Bonnie developed from a tropical wave, becoming a tropical depression on August 3 about 415 miles east of Barbados in the Lesser Antilles. The depression was moving westward rapidly, however, and could not maintain a closed surface circulation. The system degenerated to an open wave the next day in the eastern Caribbean Sea, but a depression redeveloped four days later about 115 miles southeast of the western tip of Cuba. The depression moved west-northwestward and became a tropical storm near the northeastern tip of the Yucatan Peninsula. Bonnie moved into the central Gulf of Mexico and then turned northeastward on August 11, reaching its maximum intensity of 65 m.p.h. later that day. Strong southwesterly wind shear then became established over Bonnie and the cyclone began to weaken. Bonnie made landfall just south of Apalachicola, Florida, during the afternoon on the 12th with 45 m.p.h. maximum winds. After moving inland, Bonnie weakened to a tropical depression and continued to move northeastward across eastern Georgia and the Carolinas. Bonnie produced roughly 30 tornadoes over the southeastern United States, and one of these resulted in three deaths in North Carolina. Bonnie degenerated to a weak area of low pressure near Cape Cod on the 14th.

Hurricane Charley

Charley originated from a tropical wave, developing into a tropical depression on August 9 about 115 miles south-southeast of Barbados. The depression strengthened within a low-shear environment to a tropical storm early the next day in the eastern Caribbean, and became a hurricane on the 11th near Jamaica. Charley's center passed about 40 miles southwest of the southwest coast of Jamaica, and then passed about 15 miles northeast of Grand Cayman as the hurricane reached category 2 strength on the 12th. Charley turned to the north-northwest and continued to strengthen, making landfall in western Cuba as a category 3 hurricane with 120 m.p.h. maximum winds. Charley weakened during its passage over western Cuba; its maximum winds decreased to about 110 m.p.h. by the time the center reached the Dry Tortugas around 8 am on the 13th.

Charley then came under the influence of an unseasonably strong mid-tropospheric trough that had dropped from the east-central United States into the eastern Gulf of Mexico.

The hurricane turned north-northeastward and accelerated toward the southwest coast of Florida as it began to intensify rapidly; dropsonde measurements indicate that Charley's central pressure fell from 964 mb to 941 mb in 4.5 hours. By 10 am, the maximum winds had increased to near 125 m.p.h., and three hours later had increased to 145 m.p.h. - category 4 strength. Charley made landfall with maximum winds near 150 m.p.h. on the southwest coast of Florida just north of Captiva Island around 3:45 pm. An hour later, Charley's eye passed over Punta Gorda. The hurricane then crossed central Florida, passing near Kissimmee and Orlando. Charley was still of hurricane intensity when its center cleared the northeast coast of Florida near Daytona Beach. After moving into the Atlantic, Charley came ashore again near Cape Romain, South Carolina near midday on the 14th as a category 1 hurricane. The center then moved just offshore before making a final landfall at North Myrtle Beach. Charley soon weakened to a tropical storm over southeastern North Carolina and became extratropical on the 15th.

Although ferocious, Charley was a very small hurricane at its Florida landfall, with its maximum winds and storm surge located only about 6-7 miles from the center. This helped minimize the extent and amplitude of the storm surge, which likely did not exceed 7 feet. However, the hurricane's violent winds devastated Punta Gorda and neighboring Port Charlotte. Rainfall amounts were generally modest, less than 8 inches. Charley also produced 16 tornadoes in Florida, North Carolina and Virginia. The total U. S. damage is estimated to be near $15 billion, making Charley the second costliest hurricane in U.S. history. Casualties were remarkably low, given the strength of the hurricane and the destruction that resulted. Charley was directly responsible for ten deaths in the United States. There were also four deaths in Cuba and one in Jamaica.

Hurricane Danielle

A vigorous westward-moving tropical wave moved across the west coast of Africa early on August 12, and spawned a tropical depression on the 13th southeast of the Cape Verde Islands. The cyclone strengthened quickly, becoming a tropical storm on the 14th and a hurricane on the 15th. Danielle spent its lifetime over the open waters of the central Atlantic, reaching a peak intensity of 110 m.p.h. before ultimately degenerating into a non-convective remnant low pressure system on the 21st.

Tropical Storm Earl

Earl was a short-lived tropical storm that formed from a tropical wave on August 13 over the central tropical Atlantic Ocean. It moved quickly westward, became a tropical storm the next day, and then crossed the Windward Islands on the 15th with brief but heavy rains and 50 m.p.h. winds that produced minor damage. Earl degenerated to an open tropical wave later that day over the eastern Caribbean Sea.

Hurricane Frances

Frances developed from a tropical wave, becoming a tropical depression on August 25 several hundred miles west-southwest of the southern Cape Verde Islands, a tropical storm later that day, and a hurricane the following day. Frances moved generally west-northwestward for the next several days, passing north of the Leeward Islands on the 31st and just north of the Turks and Caicos Islands on the 2nd. During this time, Frances' peak winds reached 145 m.p.h. (category 4) on two occasions while the hurricane underwent a series of concentric eyewall cycles. Westerly wind shear then caused Frances to weaken to a category 2 hurricane by the time it passed over the northwestern Bahamas on the 4th. Frances made landfall near Stuart, Florida just after midnight on the 5th with 105 m.p.h. (category 2) maximum winds. Frances gradually weakened as it moved slowly across the Florida Peninsula, and became a tropical storm just before emerging into the northeastern Gulf of Mexico early on September 6. Frances made a final landfall in the Florida Big Bend region that afternoon as a tropical storm. Frances weakened over the southeastern United States and became extratropical over West Virginia on the 9th.

Frances produced a storm surge of nearly 6 feet at its Florida east coast landfall, and caused widespread heavy rains and associated freshwater flooding over much of the eastern United States, with a maximum reported rainfall of 18.07 inches at Linville Falls, North Carolina. Frances was also associated with an outbreak of over 100 tornadoes throughout the southeastern and mid-Atlantic states. Seven deaths resulted from the forces of the storm – six in the United States and one in the Bahamas. U.S. damage is estimated to be near $8.9 billion, over 90% of which occurred in Florida.

Hurricane Gaston

Gaston developed slowly from an area of low pressure associated with a decaying frontal zone, and became a tropical depression on August 27 about 130 miles east-southeast of Charleston, South Carolina. Drifting erratically, the depression became a tropical storm the next day and continued to strengthen as it began to move toward the coast. Gaston reached hurricane strength just before making landfall in South Carolina on the morning of the 29th between Charleston and McClellanville. Gaston weakened as it moved across northeastern South Carolina, becoming a tropical depression late in the day. Gaston moved northeastward over North Carolina and across the Delmarva Peninsula on the 30th, and late in the day re-strengthened to a tropical storm as it moved back over water. Gaston accelerated east-northeastward and became extratropical on September 1 south of the Canadian Maritimes.

Gaston produced widespread flooding across South Carolina, North Carolina, and Virginia, with rainfall totals exceeding 12 inches in the Richmond area, where flash floods killed eight people. The storm generated a 4 foot storm surge at landfall and later produced 14 tornadoes. Total U.S. damage is estimated to be near $130 million.

Tropical Storm Hermine

Hermine developed from the same decaying frontal system that spawned Hurricane Gaston. An area of showers detached from the front on August 26 and the next day a tropical depression formed about 230 miles south of Bermuda. The cyclone moved toward the west-northwest, became a tropical storm on the 29th, and reached its peak intensity of 60 m.p.h. on the 30th. Hermine moved northward and began to gradually weaken under strong northerly shear caused by the outflow of Gaston. Hermine reached the southern coast of Massachusetts near New Bedford as a minimal tropical storm on the 31st, and became extratropical shortly thereafter. Hermine brought wind gusts to tropical storm force over eastern Massachusetts. There were no reports of damage or casualties.

Hurricane Ivan

Ivan developed from a large tropical wave that crossed the west coast of Africa on August 31, and spawned a tropical depression two days later. The depression reached storm strength on September 3rd (one of only a dozen on record to do so south of 10°N) and continued to strengthen. By the 5th, Ivan had become a hurricane about 1150 miles east of the southern Windward Islands. Eighteen hours later Ivan became the southernmost storm to reach major hurricane status, at 10.2°N. Ivan was a category 3 hurricane when the center passed about 7 miles south of Grenada, a path that took the northern eyewall of Ivan directly over the island. In the Caribbean, Ivan became a category 5 hurricane, with winds of 160 m.p.h., on the 9th when it was south of the Dominican Republic, and on two occasions the minimum pressure fell to 910 mb. The center of Ivan passed within about 20 miles of Jamaica on the 11th and a similar distance from Grand Cayman on the 12th, with Grand Cayman likely experiencing sustained winds of category 4 strength. Ivan then turned to the northwest and passed through the Yucatan channel on the 14th, bringing hurricane conditions to portions of western Cuba. Ivan moved across the east-central Gulf of Mexico, making landfall as a major hurricane with sustained winds of near 120 m.p.h. on the 16th just west of Gulf Shores, Alabama.

Ivan weakened as it moved inland, producing over 100 tornadoes and heavy rains across much of the southeastern United States, before merging with a frontal system over the Delmarva Peninsula on the 18th. While this would normally be the end of the story, the extratropical remnant low of Ivan split off from the frontal system and drifted southward in the western Atlantic for several days, and re-entered the Gulf of Mexico on the 21st. The low re-acquired tropical characteristics, becoming a tropical storm for the second time on the 22nd in the central Gulf. Ivan made its final landfall in southwestern Louisiana as a tropical depression on the 24th.

Ivan's storm surge completely over-washed the island of Grand Cayman, where an estimated 95% of the buildings were damaged or destroyed. Surge heights of 10-15 feet occurred along the Gulf coast during Ivan's first U.S. landfall. Peak rainfall amounts in the Caribbean and United States were generally 10-15 inches. The death toll from Ivan stands at 93 – 39 in Grenada, 26 in the United States, 17 in Jamaica, 4 in Dominican Republic, 3 in Venezuela, 2 in the Cayman Islands, and 1 each in Tobago and Barbados. U.S. damage is estimated to be near $14.2 billion, the third largest total on record.

Hurricane Jeanne

Jeanne formed from a tropical wave, becoming a tropical depression on September 13 near the Leeward Islands, and strengthening to a tropical storm the next day. Moving west-northwestward, Jeanne struck Puerto Rico on the 15th with 70 m.p.h. winds and then strengthened to a hurricane just before making landfall in the Dominican Republic. Jeanne spent nearly 36 hours over the rough terrain of Hispaniola, generating torrential rainfall before emerging into the Atlantic north of the island. Steering currents in the western Atlantic were weak, and Jeanne moved slowly through and north of the southeastern Bahamas over the next five days while it gradually regained the strength it had lost while over Hispaniola. By the 23rd, high pressure had built in over the northeastern United States and western Atlantic, causing Jeanne to turn westward. Jeanne strengthened and became a major hurricane on the 25th while the center moved over Abaco and then Grand Bahama Island. Early on the 26th, the center of Jeanne's 60-mile-wide eye crossed the Florida coast near Stuart, at virtually the identical spot that Frances had come ashore three weeks earlier. Maximum winds at the time of landfall are estimated to be near 120 m.p.h.

Jeanne weakened as it moved across central Florida, becoming a tropical storm during the afternoon of the 26th near Tampa, and then weakening to a depression a day later over central Georgia. The depression was still accompanied by heavy rain when it moved over the Carolinas, Virginia, and the Delmarva Peninsula on the 28th and 29th before becoming extratropical.

Jeanne produced extreme rain accumulations in Puerto Rico and Hispaniola, with nearly 24 inches reported in Vieques. These rains resulted in historic floods in Puerto Rico, and deadly flash-floods and mudslides in Haiti, where over 3000 people lost their lives and roughly 200,000 were left homeless. Three deaths occurred in Florida, and one each in Puerto Rico, South Carolina, and Virginia. In the United States, damage is estimated to be near $6.9 billion.

Hurricane Karl

Karl developed from a tropical wave, becoming a depression about 410 miles southwest of the southern Cape Verde Islands on September 16 and a tropical storm the following day. It remained over the open waters of the central Atlantic, reaching a peak intensity of 145 m.p.h. on the 21st. Karl lost tropical characteristics about 755 miles northwest of the western Azores on the 25^{th}, and eventually passed over Scandinavia as an extratropical low.

Hurricane Lisa

Lisa developed from a tropical wave, becoming a depression on September 19 about 520 miles west-southwest of the Cape Verde islands. The depression became a tropical storm the next day. Lisa moved westward for a couple of days, and then interacted with another tropical wave disturbance approaching Lisa from the east. The disturbance and Lisa looped about each other on the 22^{nd} and 23^{rd}, until the disturbance became absorbed into Lisa's circulation. Lisa then resumed a westward track on the 24^{th} before turning northward in the central Atlantic. Its strength oscillating, Lisa moved slowly northward for nearly a week before turning northeastward on October 1 ahead of a strong upper-level trough. Lisa strengthened, briefly maintaining category 1 hurricane intensity on the 2^{nd} before weakening back to a tropical storm that afternoon due to very cold waters and increasing vertical wind shear. Lisa became extratropical early on the 3^{rd} about 1150 miles east of Cape Race, Newfoundland.

Tropical Storm Matthew

Matthew formed about 205 miles southeast of Brownsville, Texas on October 8 from the interaction of a tropical wave with an upper-level trough. The depression became a tropical storm later that day, and the cyclone reached its peak intensity of 45 m.p.h. the following day. Steered by a large mid- to upper-level low over western Texas, Matthew made landfall just west of Cocodrie, Louisiana on the 10^{th} with 40 m.p.h. maximum winds. The weakening system moved inland and was absorbed by a frontal system on the 11^{th}. Matthew's landfall was accompanied by rains in excess of 16 inches, and a 6 foot storm surge that was enhanced by a strong pre-existing pressure gradient in the northeastern Gulf of Mexico. Damage, however, was relatively minor.

Subtropical Storm Nicole

Nicole's genesis appears to be associated with an upper-level trough and a decaying frontal system that were over the southwestern North Atlantic during the first week of October. By October 8, a broad area of surface low pressure with gale-force winds had developed about 460 miles southeast of Bermuda. On the 10^{th}, the system developed banded cloud patterns and a well-defined surface circulation center about 140 miles south of Bermuda, marking the formation of a subtropical storm. Nicole passed about 60 miles to the northwest of Bermuda on the 11^{th}, and then accelerated northeastward, becoming absorbed by an extratropical cyclone later that day.

Tropical Storm Otto

Otto developed from an extratropical occluded low that gradually acquired tropical characteristics in the central Atlantic, becoming a subtropical storm on November 29 about 1150 miles east-southeast of Bermuda, and a tropical storm the next day. Otto meandered for a couple of days until northwesterly shear reached the system and caused the cyclone to weaken while it drifted southward. Otto degenerated into a non-convective remnant low pressure system on December 3 about 920 miles southeast of Bermuda.

2004 Atlantic hurricane season statistics

Name	Class [a]	Dates [b]	Maximum wind (m.p.h.)	Minimum pressure (mb)	Direct deaths	U.S. Damage ($ millions)
Alex	Hurricane	31 Jul – 6 Aug	120	957	1	5
Bonnie	Tropical Storm	3 – 13 Aug	65	1001	3	minor[c]
Charley	Hurricane	9 – 14 Aug	150	941	15	15000
Danielle	Hurricane	13 – 21 Aug	110	964		
Earl	Tropical Storm	13 – 15 Aug	50	1009		
Frances	Hurricane	25 Aug – 8 Sep	145	935	7	8900
Gaston	Hurricane	27 Aug – 1 Sep	75	985	8	130
Hermine	Tropical Storm	27 – 31 Aug	60	1002		
Ivan	Hurricane	2 – 24 Sep	165	910	93	14200
Jeanne	Hurricane	13 – 28 Sep	120	950	3000+	6900
Karl	Hurricane	16 – 24 Sep	145	938		
Lisa	Hurricane	19 Sep – 3 Oct	75	987		
Matthew	Tropical Storm	8 – 10 Oct	45	997		minor[c]
Nicole	Subtropical Storm	10 – 11 Oct	50	986		
Otto	Tropical Storm	29 Nov – 3 Dec	50	995		

[a] Tropical or subtropical storm: wind speed 39-73 m.p.h. Hurricane: wind speed 74 m.p.h. or higher.

[b] Dates begin at 0000 UTC and include tropical and subtropical depression stages but exclude extratropical stage.

[c] Only minor damage was reported, but the extent of the damage was not quantified.

EASTERN NORTH PACIFIC

Tropical cyclone activity was below average in the eastern North Pacific in 2004. There were twelve named tropical cyclones; six of these became hurricanes. Three of the hurricanes reached category three or higher intensity on the Saffir-Simpson Hurricane Scale, far from land. The long-term averages for this basin are sixteen named tropical cyclones and nine hurricanes. In addition, there were three tropical depressions which remained at sea and one that affected Mexico. The genesis of most of the tropical cyclones was associated with westward-moving tropical waves.

The season was benign, with no reports of deaths or damage attributed to tropical cyclones during 2004. None of the cyclones made landfall as tropical storms or hurricanes. However, Javier reached Baja California as a tropical depression, and Tropical Storm Lester brushed the southwest coast of Mexico. Tropical Depression Sixteen-E, the last cyclone of the season, was a short-lived cyclone that developed about 315 miles south-southeast of Cabo San Lucas Mexico early on October 25. The depression moved northward and crossed the extreme southeastern portion of the Sea of Cortez, before moving inland along the northwestern coast of Mexico midway between Guasave and Topolobampo on October 26. Heavy rains fell along the coastal and mountain regions of west-central and northwestern Mexico causing some localized flooding and the mid-level moisture associated with the depression eventually spread northeastward over northern Mexico and into portions of the U.S. southern plains

In the cyclone summaries given below, all dates are based on Universal Coordinated Time, although local time is implied with expressions such as “afternoon”, “mid-day”, etc. Distances are given in statute miles.

Tropical Storm Agatha

Agatha, the first tropical cyclone of the season, formed from an area of disturbed weather associated with a tropical wave and a nearly stationary area of low pressure on May 22 about 575 miles south-southeast of Cabo San Lucas, Mexico. Agatha moved slowly toward the northwest and under very light wind shear the cyclone strengthened, and it is estimated that it reached its peak intensity of 55 mph on May 23. Soon thereafter, cooler sea surface temperatures and stable air caused the cyclone to gradually weaken, and Agatha degenerated to a nearly stationary remnant low by May 24. This low dissipated about 350 miles south of Cabo San Lucas.

Tropical Storm Blas

Blas formed from a tropical wave that emerged from western Africa on July 1 and crossed Central America on July 8. Over the next several days, deep convection increased and slowly became organized to the south of Mexico. The system became a tropical depression on July 12 about 320 miles south of Manzanillo, Mexico, and strengthened into a tropical storm later that day. The storm moved northwestward at a relatively fast forward speed around the southwest side of a mid-level anticyclone centered over the southwestern United States, and reached its estimated peak intensity of 60 mph on the 13th. Blas moved over cooler waters and weakened to a tropical depression by the 14th. It soon degenerated to a remnant low that dissipated well to the west of central Baja California.

Hurricane Celia

Celia, the first hurricane of the season, formed from a fairly vigorous tropical wave that moved off the west coast of Africa on July 5. The wave moved westward across the tropical Atlantic and northern South America for the next week and emerged over the northeast Pacific Ocean near Panama on July 13. There, a low-level circulation became better defined and convection gradually increased. However, it was not until early on the 19th that the convective organization and circulation increased sufficiently for the system to be designated a tropical depression. By then, the cyclone was located about 620 miles south-southwest of the southern tip of Baja California. Steady development continued as the cyclone moved west-northwestward around the southern periphery of a subtropical high pressure ridge, and it is estimated that Celia reached a maximum intensity of 85 mph on July 20. Thereafter, Celia began a slow weakening trend as it moved over cooler water, and it eventually degenerated into a remnant low on July 26. The system dissipated about 1725 miles west-southwest of Cabo San Lucas.

Hurricane Darby

Darby's formation is associated with a tropical wave that reached the eastern Pacific on July 20 and first showed signs of organization on July 24. It was not until July 26 that a tropical depression formed, about 785 miles south-southwest of Cabo San Lucas. The tropical cyclone moved west-northwestward and strengthened to a tropical storm the next day. Darby became a hurricane on the 28th and reached its estimated maximum intensity of 120 mph on the 29th. Darby turned westward on July 30 as it weakened to a tropical storm. The cyclone became a depression on the 31st shortly before entering the central Pacific tropical cyclone basin. It continued westward and dissipated on August 1 about 850 miles east of the Hawaiian Islands.

Tropical Storm Estelle

Estelle formed from an area of disturbed weather associated with the intertropical convergence zone that was enhanced by the arrival of a tropical wave. It became a tropical depression on August 19 about 1450 miles east-southeast of Hilo Hawaii, and based on data from a QuikSCAT pass, it is estimated that the cyclone reached tropical storm status on the 20th. Estelle moved toward the west-northwest and its maximum winds reached 70 mph on the 21st. Thereafter, the cyclone began to move toward the west and west-southwest, and weakened due to strong wind shear. Estelle became a remnant low that dissipated on August 26 about 350 miles south of the Hawaiian Islands.

Hurricane Frank

Frank formed from the same wave that spawned Tropical Storm Earl in the Caribbean Sea. The wave continued westward and crossed Central America on August 18. Over the next five days, deep convection gradually increased and by early on August 23, the convection was organized enough to classify the system as a tropical depression about 420 miles south of Cabo San Lucas. It is estimated that the cyclone strengthened into a tropical storm and then rapidly became a hurricane later on the 23rd, when an eye feature became apparent in visible and microwave imagery. Frank moved west-northwestward to northwestward and reached its peak intensity of 85 mph on August 24. Thereafter, Frank gradually weakened due to cooler sea-surface temperatures and turned back toward the west-northwest. The circulation remained well-defined but the cyclone finally degenerated to a remnant low on the 26th and dissipated later that day about 690 miles west of Cabo San Lucas.

Tropical Storm Georgette

Georgette formed from a tropical wave that reached the Gulf of Tehuantepec on August 24. A QuikSCAT overpass indicated a weak surface low pressure area formed along the wave axis early on the 25th. The cloud pattern became sufficiently well-organized to designate the system a tropical depression on August 26, about 600 miles south-southeast of the southern tip of Baja California. Deep convection continued to become better organized and it is estimated that the tropical cyclone strengthened into Tropical Storm Georgette later on the 26th . The storm reached its peak intensity of 60 mph on the 27th. Shortly thereafter, upper-level northeasterly wind shear became established over the cyclone. Georgette slowly weakened while it moved west-northwestward over cooler water, and degenerated into a remnant low on August 30th. The low remained devoid of significant convection as it moved west-northwestward over progressively colder water for the next 4 days. It finally dissipated early on 3 September about 600 miles northeast of the Hawaiian Islands.

Hurricane Howard

Howard formed from a tropical wave on August 30 about 400 miles south-southwest of Acapulco, Mexico. It moved toward the west-northwest away from the coast and reached hurricane strength on September 1. Howard turned northwestward and reached an estimated peak intensity of 140 mph on September 2. This was followed by a gradual weakening as Howard moved northwestward over cooler sea surface temperatures. The cyclone became a remnant low on September 5 about 260 miles west-southwest of Punta Eugenia. The remnant low continued slowly northwestward and finally dissipated about 1,150 miles west-southwest of Cabo San Lucas.

Hurricane Isis

Isis developed from a tropical wave that entered the eastern North Pacific basin on 3 September and continued westward for several days. By September 8, when the disturbance was located about 530 miles south of Cabo San Lucas, Mexico, it had sufficient circulation and convective organization to be considered a tropical depression. The depression strengthened and became a tropical storm on the 18th and moved generally westward for the next several days. Under easterly shear the cyclone weakened back to a depression on September 10 when its deep convection temporarily evaporated. Isis re-strengthened to a tropical storm on the 12th about 835 miles west-southwest of Cabo San Lucas, and its maximum winds reached 50 mph later that day. There was little change in strength until 14 September. However, the easterly shear had been decreasing, and late in the day Isis again re-strengthened – this time rapidly. Isis developed a ragged eye, and is estimated that the cyclone reached its maximum winds of 75 mph on September 15, about 1450 miles west of Cabo San Lucas. As quickly as the eye had developed, it disappeared. Isis moved over cool waters and steering currents collapsed, resulting in little motion and weakening. The system degenerated to a remnant low on September 16 about 1500 miles west of Cabo San Lucas. The remnant low drifted southwestward and then westward for a few days, generating intermittent convection before dissipating on 21 September about 1,000 miles east of the Hawaiian Islands.

Hurricane Javier

Javier, the strongest hurricane of the season, formed from a tropical wave that entered the eastern Pacific on September 9 and moved westward with deep convection and limited upper-level outflow. The system developed into a tropical depression on September 10 about 345 miles south-southeast of Salina Cruz, Mexico and became a tropical storm on the 11th. Under light wind shear, Javier continued to strengthen, and reached hurricane status on the 12th. The hurricane then moved slowly between the west-northwest and northwest around the periphery of a subtropical ridge centered over Mexico. On September 13, Javier intensified at a rapid rate as indicated by the quick development of a distinct eye. The hurricane reached its estimated peak intensity of 150 mph on September 14, when the cyclone was located about 300 miles south-southwest of Manzanillo, Mexico. Thereafter, Javier weakened, but maintained category 3 intensity on the Saffir/Simpson Hurricane Scale for the next three days. Javier moved northwestward over cool waters, and this along with strong southwesterly wind shear resulted in weakening. The cyclone then turned north and north-northeastward, and as a weakening tropical depression, crossed Baja California between Cabo San Lazaro and Punta Abreojos in the morning of September 19. The depression continued toward the north-northeast over the Sea of Cortes and weakened to a remnant low later on the 19th. This low moved inland near Guaymas, Mexico, and dissipated over the high terrain of the state of Sonora. Mid-level moisture from Javier spread northeastward over northern Mexico and the southwestern United States.

Tropical Storm Kay

Kay developed into a tropical depression from an area of disturbed weather associated with a tropical wave and a disturbance in the intertropical convergence zone on October 4 about 590 miles southwest of Manzanillo, Mexico. Geostationary satellite imagery, Quikscat and TRMM data indicated the depression strengthened to a tropical storm early on the 5th approximately 735 miles west-southwest of Manzanillo. Kay moved west-northwestward around the southwest side of a strong mid-level anticyclone centered over the southwestern United States and reached its peak intensity of 45 mph on October 5. Thereafter, deep convection decreased and the center of the cyclone remained separated from the main area of thunderstorms. Kay gradually weakened and degenerated to a remnant low on October 6, and dissipated later that day about 865 miles west-southwest of Cabo San Lucas.

Tropical Storm Lester

Lester developed on October 11 about 100 miles south of Puerto Escondido, Mexico. The depression moved slowly west-northwestward very near the Mexican coast, and became a tropical storm late on the 12th while located about 60 miles southeast of Acapulco. Lester reached its peak intensity of 50 mph 6 to 12 hours later. Based on radar images from Mexico, the center passed just south of Acapulco early on October 13. The interaction with both land and a larger low pressure area to the southwest began to weaken the cyclone, and data from an Air Force Reserve Unit Hurricane Hunter Aircraft indicated that Lester had degenerated into a trough of low pressure late on the 13th. Lester brought locally heavy rainfall to portions of the Mexican states of Oaxaca and Guerrero, but no reports of any significant flooding, casualties or damages were received.

2004 Eastern Pacific hurricane season statistics

Storm	Class	Dates	Winds (mph)	Pressure (mb)
Agatha	T	22-24 May	60	997
Blas	T	12-15 July	60	991
Celia	H	19-25 July	85	981
Darby	H	26 July -1 August	120	957
Estelle	T	19-24 August	70	989
Frank	H	23-26 August	85	979
Georgette	T	26-30 August	65	995
Howard	H	30 August-5 September	140	943
Isis	H	8-16 September	75	987
Javier	H	10-19 September	150	930
Kay	T	4-6 October	45	1005
Lester	T	11-13 October	50	1000

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.

APPENDIX IV

REPORTS OF HURRICANES, TROPICAL STORMS, TROPICAL DISTURBANCES AND RELATED FLOODING DURING 2004

(Submitted by Members)

2004 HURRICANE SEASON SUMMARY

(Submitted by 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.).

This year (up to Nov. 1st), there were fourteen (14) storms, eight (8) of which developed into hurricanes and of those eight hurricanes, six (6) developed further into intense hurricanes.

The period August 20th to September 20th was particularly active, generating seven (7) Tropical Storms, five of which developed into hurricanes and of those five hurricanes, four developed further into intense hurricanes.

Antigua and Barbuda were quite fortunate not to be affected this year even though:

(1) A tropical storm warning was issued for Antigua and Barbuda due to the proximity of Tropical Storm Frances;

(2) Tropical Depression # 11 which was later upgraded to Tropical Storm Jeanne and later to Hurricane Jeanne, developed between Antigua and Guadeloupe on 13th September;

This system (T.D. # 11) generated approximately 2.03 inches of rainfall in a 27-hour period beginning 5:00 p.m. on September 13th. Some flooding was reported in low-lying areas.

During the month of October, a near stationary/meandering upper level trough was responsible for most of the month’s total rainfall of 9.81 inches. This total (9.81 inches) made October 2004 the second wettest October on record.

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

THE BAHAMAS AND TURKS AND CAICOS REPORT OF THE 2004 ATLANTIC HURRICANE SEASON

(Submitted by The Bahamas)

During the 2004 Atlantic Hurricane Season, The Bahamas was affected by two cyclones, while one affected the Turks and Caicos Islands, Frances, the second major hurricane for the season, affected both The Bahamas and the Turks and Caicos Island with its center passing near the Turks and Caicos Islands and through The Bahamas. Within three weeks after Frances moved away from the islands of the northern Bahamas, the center of Jeanne, the fifth major hurricane of the season, moved over those islands.

At 11 p.m. Tuesday, August 24th, satellite images indicated that a tropical depression had formed from a strong tropical wave in the Eastern Atlantic, some 870 miles west-southwest of Cape Verde; movement was to the west at 17 miles per hour. The next day, at 5 p.m., the depression was upgraded to tropical storm status and given the name Frances. The storm was upgraded to a hurricane on Thursday, August 26th, at 5 p.m.

The hurricane strengthened rapidly and reached category 3 status (111 to 130 miles per hour) intensity on the Saffir-Simpson scale on the 27th at 5 p.m., and, exactly 24 hours later, to category 4 status (winds of 131 to 155 miles per hour). France's intensity fluctuated over the next few days reaching a peak value of 145 miles per hour on September 2nd and 2 a.m. It was with that wind force that Frances passed directly over the island of San Salvador and very near to Cat Island.

Until 8 a.m. September 3rd, Frances moved at an average speed of 13 miles per hour in a west to north-west direction. At the exact time, the hurricane moved over or near James Cistern, Eleuthera with decreasing forward speed. Later on the same day, the hurricane underwent a weakening process as it passed into the vicinity of Abaco and directly over Grand Bahama. Prior to passing over Grand Bahama, Frances weakened from a category 3 to 2 with a further decrease in forward speed of approximately 5 miles per hour. At 3 a.m. on Sunday, September 5th, the center of the broad eye of Frances finally moved away from The Bahamas and inland over Florida.

Two deaths occurred in the Bahamas as a result of Frances, one in New Providence and the other in Freeport, Grand Bahama. Also civil infrastructure, both public and private, in many islands was severely impacted.

Tropical Depression Eleven formed from a tropical wave 70 miles east-southeast of Guadeloupe in the Lesser Antilles at 5 p.m., Monday, September 13th, and was upgraded to Tropical Storm Jeanne at 11 a.m. the next day.

Jeanne moved west-northwestward between 8 and 12 miles per hour and attained hurricane strength on September 16th but rapidly lost its strength on September 17th and became a depression once again as it moved across the Dominican Republic.

On September 18th, while the system was near Great Inagua, a new center formed well to the northeast and the previous circulation dissipated. The new Center strengthened again, becoming a hurricane on September 20th at 5 p.m.

Jeanne meandered for several days before being constrained to move in a westerly direction toward the northwest Bahamas. This behaviour was similar to that of Hurricane Betsy of 1965 and presented numerous challenges for forecasters and their models.

Jeanne continued to strengthen as it headed toward the west, passing over Abaco on the morning of September 25th. Shortly thereafter, it reached category 3 status on the

Saffir-Simpson scale and maintained this intensity as it passed over Grand Bahama during the remainder of the day.

There were no deaths or reported sickness associated with Jeanne. Many residents in the extreme northwest Bahamas (Abaco and Grand Bahama, in particular), however, had to undergo psychiatric evaluation after experiencing two hurricanes in approximately three weeks and losing all of their belongings.

Each year during the month of May, The Bahamas Department of Meteorology utilizes the media (radio and television) to inform the public of the dangers of hurricanes and the necessary precautions and preparations to take if it is warranted. Based on the amount of calls that the Department received and the significant scale back of personal injuries during each hurricane, we feel confident in stating that the information being disseminated to the public is being seriously taken and acted upon.

A more detailed report of each hurricane will be submitted to the Secretariat in the near future.

2004 HURRICANE SEASON

(Submitted by Barbados)

The 2004 Atlantic hurricane season represents one of the busiest and most devastating in history, with tropical cyclone activity well above average. By the end of the season fifteen named storms had developed, nine of which reached hurricane intensity and of these, six were classified as major hurricanes. A record number of eight tropical cyclones attained storm strength in august and by the end of September six major hurricanes had been recorded.

Three tropical cyclones threatened Barbados from early in August to the first week in September. Charley, the first of the hurricanes impacting Florida this year, originated from a tropical wave, became a tropical depression on August 9 just east of Barbados and briefly threatened the island before moving quickly across the Caribbean. Four days later, T.D. #5 formed from a vigorous tropical and evolved into short-lived tropical storm Earl on 14th of August. Ivan, a long-lived Cape Verde major hurricane, represented a significant threat to Lesser Antilles during the early part of September, caused some structural damage in Barbados and proceeded to devastate Grenada on August 7, 2004.

Tropical depression number five, while located about 530 miles east southeast of Barbados on the morning of Saturday, August 14, necessitated the issuance of a tropical storm watch by Barbados and St. Lucia, as it nears tropical storm strength. As the depression headed at a rapid 24 mph toward the west-northwest, the watch was extended to include St. Vincent and the Grenadines in the early afternoon. By 5pm the depression had strengthen into the fifth tropical storm of the season, and this resulted in the upgrading to warning status for the entire southern, including Trinidad and Tobago.

Earl's center passed about 100 miles south of Barbados early on august 15 and generated some adverse weather on the island, with wind gusts to 42 knots being recorded. Earl crossed the southern Windward Islands later on the 15th, resulting in some minor property damage in Grenada and St. Vincent. Earl degenerated into an open tropical wave over the Eastern Caribbean Sea later that day.

From early it was evident that Ivan represented a major challenge as it strengthened rapidly from depression status on September 2 to a tropical storm on the 3rd while south of 10 degrees north, and a major category 3 hurricane by the 5th, while heading directly for the southern Windward Islands.

The forecast and warning system went into high gear on September 5th, when the threat from Ivan became clearer and more definitive. From 1500UTC on this day when Ivan was a category 1 hurricane located about 930 miles east southeast of Barbados to late on the 7th, regular, relevant and reliable information on Ivan was disseminated. Between the late morning and early afternoon Sunday September 5th Ivan underwent rapid intensification to become the fourth major hurricane of the season. This, in combination with the fact Ivan was still moving rapidly westward represented a significant forecasting challenge. A hurricane watch became effective for Barbados from 5 pm on September 5th, and local interests were advised to monitor the progress and development of this dangerous and potentially destructive hurricane.

Ivan lashed Barbados with strong tropical storm force winds and inflicted more than $5.0 million in structural damage. The maximum sustained winds recorded at the Meteorological Office was 69.5 mph, with gusts to 92mph. Rainfall amounts measured across the island were not large, with less than one inch falling in most areas. One person was found dead, but it is unsure whether the single recorded loss of life was directly attributable to Ivan.

A total of 531 houses receiving damage, ranging from mild to severe, with 43 of these falling into the severe category of being completely destroyed.

A number of adverse weather events, ranging from strong winds to torrential downpours were recorded on the island from as early as April, and continued into the month of June. Localized winds caused damage to a number of houses located in different parts of the island, and regular flood events resulted in some measure of disruption. During the period from April to June, 2004, the total rainfall recorded was approximately 290 percent of the historical average for the same period.

In the end, 2004 turned out to be wettest year since 1981, and the month of November contributed approximately twenty-five per cent of the annual rainfall. Major flooding and some land slippage caused damage, destruction and dislocation to many communities across the island. Agricultural losses were significant with the crop and livestock sectors suffering the most.

2004 TROPICAL CYCLONE SEASON SUMMARY

(Submitted by Canada)

Eight tropical cyclones or their remnants entered the Canadian Hurricane Centre (CHC) Response Zone (RZ) in 2004: two remained outside Canadian waters, three moved through Canadian waters, and three moved inland following onset of extratropical transition (ET). In addition, upper tropospheric remnants of Hurricane Ivan (which itself remained outside of the CHC RZ) provided the necessary ingredients for one of Atlantic Canada's most powerful baroclinic storms of 2004. The storms outlined here claimed at least 7 lives. The CHC issued 104 bulletins during 2004.

BULLETIN SUMMARY							
	2004	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**
Hurricane Information Statements (WTCN3X/7X CWHX)	**104**	**113**	**68**	**110**	**109**	**71**	**42**
Number of Storms Represented by these Bulletins	**8**	**8**	**8**	**6**	**8**	**6**	**2**

<u>Alex (July 31–August 6)</u>

Hurricane Alex was in the RZ 040900–060800 UTC August. Alex strengthened to category 3 well within the RZ making it only the 2nd tropical cyclone to reach major hurricane status at such a northerly latitude. Alex moved into southeastern Canadian waters near 051700 UTC as a strong category 2 / weak category 3 hurricane and subsequently weakened rapidly as it underwent ET. No impacts were reported from Canadian waters or territory. The CHC issued 26 bulletins.

<u>Bonnie (August 3–13)</u>

Tropical Depression Bonnie became an ET as it entered the RZ south of Cape Cod at 132000 UTC. The remnant low tracked through the Maritimes where it combined with a baroclinic system approaching from the west. The combined weather system produced heavy rains—with amounts as high as 90 mm in Edmunston—over northwestern New Brunswick which resulted in flooded basements and road washouts and closures. One storm-induced traffic fatality was reported from Edmunston, New Brunswick. The CHC issued 5 bulletins.

<u>Charley (August 9–14)</u>

Tropical Storm Charley underwent ET just prior to entering the RZ along the east coast of the USA at 150300 UTC. The remnant surface low merged with a frontal system moving through the Maritimes on August 15 bringing local periods of strong winds (less than 65 km/h) and heavy rains. Apart from a brief interruption in some marine activities Charley had no significant impacts in Canadian waters or territory. The CHC issued 15 bulletins.

<u>Frances (August 25–September 8)</u>

Tropical Storm Frances entered the RZ at 082200 UTC. After undergoing ET the remnant low passed through extreme southeastern Lake Ontario at marginal gale strength on the morning of September 9. Although the storm centre never entered inside the provincial boundary of Ontario, very heavy rains to the north of the low caused widespread flooding throughout communities in southeastern Ontario. The nation's capital received a record 135 mm of rain with the highest amount of 137 mm reported from Kingston. In late 2004 the Insurance Bureau of Canada estimated more than $45 million in Ontario insurance claims had already been submitted. The remnant low continued through eastern Canada delivering 50-70 mm north of its track. Localized flooding and road washouts were reported in the provinces of Quebec, New Brunswick, and Newfoundland. No fatalities were recorded. The CHC issued 6 bulletins.

Gaston (August 27–September 1)

Tropical Storm Gaston entered the RZ at 310300 UTC and maintained gale strength at 83 km/h as it entered western Canadian waters late on the 31st. Gaston completed ET as it passed south of Sable Island on the morning of September 1. Heavy rain north of Gaston just missed mainland Nova Scotia but fell at Sable Island which recorded 72 mm in four hours (35 mm in one hour). No significant impacts were reported from Canadian waters or territory. The CHC issued 20 bulletins.

Hermine (August 27–31)

Tropical Storm Hermine entered the RZ at 301700 UTC at a strength of 83 km/h. A weak interaction with Tropical Storm Gaston caused Hermine to weaken as it tracked towards Cape Cod, following which, it became extratropical. The remnant low centre tracked up the Bay of Fundy on August 31 bringing locally heavy rain to portions of southern New Brunswick which received 40–55 mm. Minor basement flooding and street closures were reported from Moncton, New Brunswick. The CHC issued 7 bulletins.

Additional Information

Preemptive bulletins were also issued for TD Jeanne (18) and STC Nicole (7) which entered the RZ but did not enter or have impact on Canadian waters or territory. Coordination with the U.S. National Hurricane Center and affected Canadian Regional Weather Centres (Ontario, Québec, New Brunswick, Nova Scotia, and Newfoundland) preceded the issuance of bulletins.

Special note must be made of the impacts of Hurricane Ivan on Canada. After wrecking havoc through the Caribbean and United States, Ivan weakened to a tropical depression prior to becoming extratropical inland on August 18 as it reached as far north as the RZ. The often-difficult-to-find surface remnants of Ivan then turned east and moved through southern Maryland before heading offshore and turning back south, eventually moving through Florida and back into the Gulf of Mexico where it was once again declared to be a tropical storm. As the remnant surface circulation of Ivan was turning back south on August 18-19, the mid-upper tropospheric moisture and vorticity continued northeastward along a frontal system and fed directly into a developing baroclinic storm over Atlantic Canada. The result was a powerful 4-day storm which became one of the most significant weather events in Atlantic Canada in 2004. High winds—gusting as high as 143 km/h along the northeast coast of Newfoundland—were responsible for tree blowdowns and power outages in Prince Edward Island, Newfoundland, and eastern Nova Scotia. Heavy rainfall reached its peak in Newfoundland where three different observing sites each reported in excess of 150 mm (Gander reported 91 continuous hours of precipitation giving 157.6 mm). Seas were estimated to be near 8 m in the Cabot Strait while public reports were received of 15-m swells near Cape Bonavista. Two lives were lost when a fishing vessel was grounded near Cape Bonavista, Newfoundland, and four storm-induced traffic fatalities were also reported from Newfoundland. All forecasts and warnings for this baroclinic system were handled by the Environment Canada regional weather centres; accordingly, the CHC did not issue any bulletins.

(available in Spanish only)

INFORMES SOBRE HURACANES, TORMENTAS TROPICALES PERTURBACIONES TROPICALES E INUNDACIONES ASOCIADAS CON ESOS FENÓMENOS DURANTE 2004

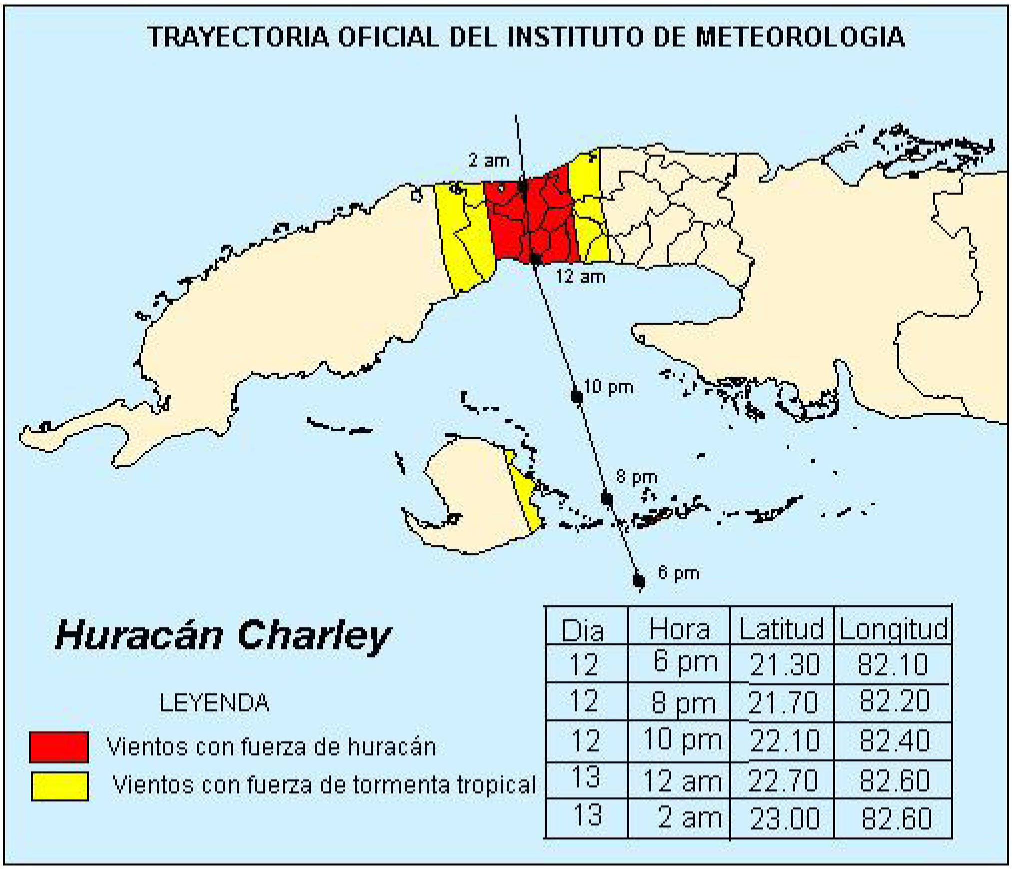
(Presentado por Cuba)

Introducción

La temporada ciclónica del 2004 fue muy activa para Cuba, con el impacto directo del huracán “Charley” de gran intensidad (Categoría 3) en fecha tan temprana como el 13 de agosto, seguido de la amenaza y el azote al extremo occidental de Cuba, del huracán “Iván”, también de gran intensidad (Categoría 5), exactamente un mes después.

HURACAN CHARLEY

En la Fig. 1 se presenta un segmento de la trayectoria de Charley a su paso sobre el archipiélago cubano, así como la extensión de los vientos huracanados y con fuerza de tormenta tropical. Aquí se puede apreciar que el centro entró en el territorio cubano por las inmediaciones de Cayo Avalos, 35 kilómetros al este de Punta del Este, Isla de la Juventud, cerca de las 7:00 PM (23:00 UTC) del día 12. Con rumbo al norte - noroeste se dirigió hacia la región occidental de Cuba. El ojo penetró cerca de Punta Cayamas, entre Playa Guanimar y Playa Cajío, costa sur de la provincia La Habana a la medianoche (04:00 UTC). El ojo tenía al penetrar un diámetro de 18 kilómetros y los vientos huracanados se extendieron hasta 23 kilómetros a la derecha y 19 kilómetros a la izquierda de la trayectoria. El ojo de Charley tenía 15 kilómetros de diámetro al salir por las inmediaciones de Menelao Mora aproximadamente a las 2:30 AM (06:30 UTC) del día 13. El movimiento medio sobre Cuba fue en dirección al norte - noroeste con una velocidad de traslación de 25 km/h. Charley fue un huracán muy pequeño (pigmeo).



Dia	Hora	Latitud	Longitud
12	6 pm	21.30	82.10
12	8 pm	21.70	82.20
12	10 pm	22.10	82.40
13	12 am	22.70	82.60
13	2 am	23.00	82.60

El área de calma dentro del centro duró aproximadamente 30 minutos. Según testimonios, se pudo observar con claridad las estrellas y hubo algunos reportes de que el cielo tuvo una apariencia rojiza dentro del ojo. La calma vorticial fue reportada en Alquízar con duración de 30 minutos alrededor de la 1:00 AM (05:00UTC). Otras localidades de La Habana que reportaron calma fueron: El Junco (20 minutos), Caimito (20 – 25 minutos), Guanajay (23 minutos), Reparto Nuevo Mariel (15 minutos), Menelao Mora (20 – 25 minutos) y El Salado (15 minutos).

Charley incrementó ligeramente su fuerza cuando cruzó Cuba. Esa intensificación pudo ser causada al pasar sobre el Golfo de Batabanó, entre la Isla de la Juventud y la costa sur de La Habana, donde las aguas son muy calientes. Los vientos máximos sostenidos (estimados) al entrar por la costa sur de La Habana fueron de 180 km/h. Un avión de reconocimiento midió 973 hPa hora y media antes de entrar el huracán en área terrestre. Una estación meteorológica Vaisala localizada en el aeropuerto de Playa Baracoa, al oeste de Ciudad de La Habana y justamente dentro de la pared del ojo midió 190 km/h (media en 1 minuto), 240 km/h en rachas y la presión mínima de 974 hPa. Este dato es confirmado por otra estación Vaisala ubicada en San Antonio de los Baños, también en la parte este de la pared del ojo, donde los vientos máximos sostenidos medidos fueron de 180 km/h, con rachas de hasta 212 km/h. La intensidad del huracán es corroborada además por los datos de la estación meteorológica de Güira de Melena, localizada también en la pared el ojo. Aquí se registraron vientos máximos sostenidos de 170 km/h, rachas de hasta 214 km/h y la presión mínima de 971.6 hPa. Por tanto, Charley fue definitivamente un huracán de Categoría 3 al cruzar La Habana.

No hubo ninguna estación meteorológica dentro del recorrido del ojo, pero tomando en cuenta los datos referidos a la pared derecha del ojo, que fue cubierta desde la costa sur de La Habana hasta la costa norte, así como la distancia de los registros hasta el mismo centro del ojo, se estimó que la presión mínima central era 966 hPa. Con respecto al viento máximo sostenido (1 minuto) se consideró el registrado de 190 km/h.

Tabla 1. Vientos máximos sostenidos (estimados) en km/h (promedio en un minuto) y rachas máximas registradas en algunas estaciones cubanas al paso de Charley el 12-13 de agosto de 2004.

No. Estación	Localidad	**Viento Máximo Sostenidp (km/h)**	**Racha Máxima Registrada (km/h)**
78324	Punta del Este	67	84
78321	Nueva Gerona	73	91
78320	**Güira de Melena**	**170**	**214**
78373	Santiago de las Vegas	117	146
78325	Casa Blanca	113	141

Charley fue un huracán más bien seco. La cantidad máxima de lluvia acumulada en 24 horas reportada osciló 100 – 150 milímetros en áreas restringidas a lo largo del paso de la pared del ojo. Las bandas exteriores sólo produjeron precipitaciones intensas en aislados puntos de la Isla de la Juventud y Matanzas. En la Tabla 5 se presentan los mayores acumulados (más de 100 milímetros en 24 horas) en Cuba y en la Fig. 5 las áreas de nublados y lluvias asociadas al huracán cuando su ojo se hallaba sobre el municipio de Alquízar, La Habana, en las primeras horas de la madrugada del día 13.

Tabla 2. Mayores acumulados de lluvias registrados en 24 horas al paso de Charley por Cuba.

Localidad y Provincia	Día	mm/24 horas
Punta del Este, Isla de la Juventud	12	125.7
Cayo Largo del Sur, Isla de la Juventud	12	120.0
Playa Larga, Matanzas	12 - 13	171.1
Méndez Capote, Matanzas	12 - 13	105.8
Mariel, La Habana	**13**	**149.0**
Vereda Nueva, La Habana	13	144.6
Melena del Sur, La Habana	13	130.0
Ceiba del Agua, La Habana	13	128.7
Caimito, La Habana	13	128.5
Guara, La Habana	13	118.5
CAI Osvaldo Sánchez, La Habana	13	110.0
La Sabana, La Habana	13	104.0
Surgidero de Batabanó, La Habana	13	104.0
Güines, La Habana	13	102.7

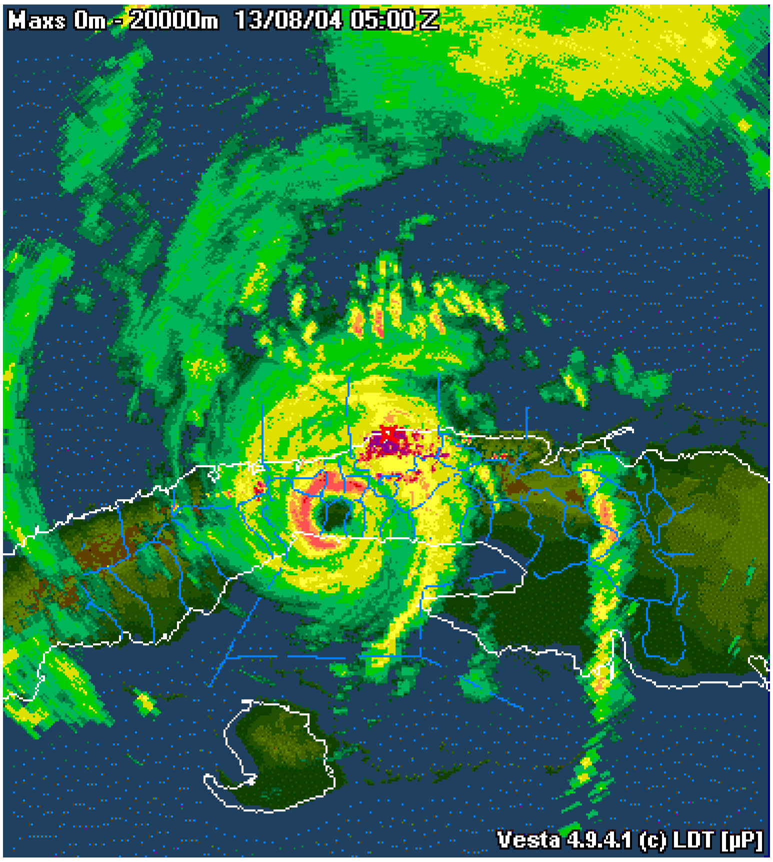


Fig. 2 Áreas de lluvias del huracán Charley captadas por el radar meteorológico de Casa Blanca a las 05:00 UTC (a) e imagen IR del satélite GOES-12 a las 05:01 UTC del 13 de agosto de 2004.

En Playa Cajío se observó una marea de tormenta de cuatro metros por encima del nivel del mar y fueron barridas 360 casas. Las aguas del mar llegaron hasta 2.6 kilómetros tierra adentro. En Surgidero de Batabanó la marea de tormenta fue de 2.8 metros de altura y el mar entró hasta 1.5 kilómetros.

Charley ocasionó daños considerables en viviendas, cosechas, árboles, líneas eléctrica y telefónicas y en la estructura general de la porción oeste de La Habana, en el oeste de Ciudad de La Habana y la parte este de Pinar del Río. Sin embargo, sólo se reportaron cuatro muertes en este huracán de Categoría 3 que afectó a Cuba, el primero de tal intensidad que lo hace en las provincias habaneras desde 1948.

Después de pasar por Cuba, el huracán se internó en el mar con igual rumbo hasta la mañana del 13 en se dirigió al norte - nordeste con mayor rapidez e incremento en su intensidad. Alcanzó la Categoría 4 esa mañana y llegó a tener vientos máximos sostenidos del orden de los 230 km/h y la presión mínima central de 941 hPa, reportada por un avión de reconocimiento a las 19:57 UTC.

Hubo que lamentar sólo 4 muertes al paso de Charley, fundamentalmente por imprudencias de personas aisladas. Fueron evacuadas 224 449 personas y los daños materiales fueron estimados en 923 millones de dólares estadounidenses, principalmente en la agricultura, casas y edificaciones, así como en la infraestructura eléctrica y telefónica.

HURACAN IVAN

Después de moverse por el Mar Caribe y fluctuar en su intensidad máxima, "Iván" cruzó, en la mañana del día 12, por los mares al sur y muy cerca de Caimán Grande. En la noche alcanzó de nuevo la Categoría 5 en el noroeste del Caribe. En la madrugada del 13, cuando se hallaba al sur – suroeste de la Isla de la Juventud, inclinó la trayectoria hacia el noroeste, arrastrado por la dorsal anticiclónica subtropical.

En la Fig. 3 se muestra un segmento de la trayectoria de Iván al pasar cerca de Cuba y la influencia de los vientos huracanados, con fuerza de tormenta tropical y de depresión tropical sobre Pinar del Río, la Isla de la Juventud y las provincias habaneras. En la figura se aprecia que el centro de Iván estuvo más próximo a la Isla de la Juventud en la mañana del día 13 (12:00 UTC) a unos 180 kilómetros al suroeste. Esa mañana se registraron rachas de vientos huracanados en la Isla de la Juventud y resulta significativo que ese territorio fue afectado por vientos con fuerza de tormenta tropical durante 47 horas consecutivas en algunas de las estaciones meteorológicas.

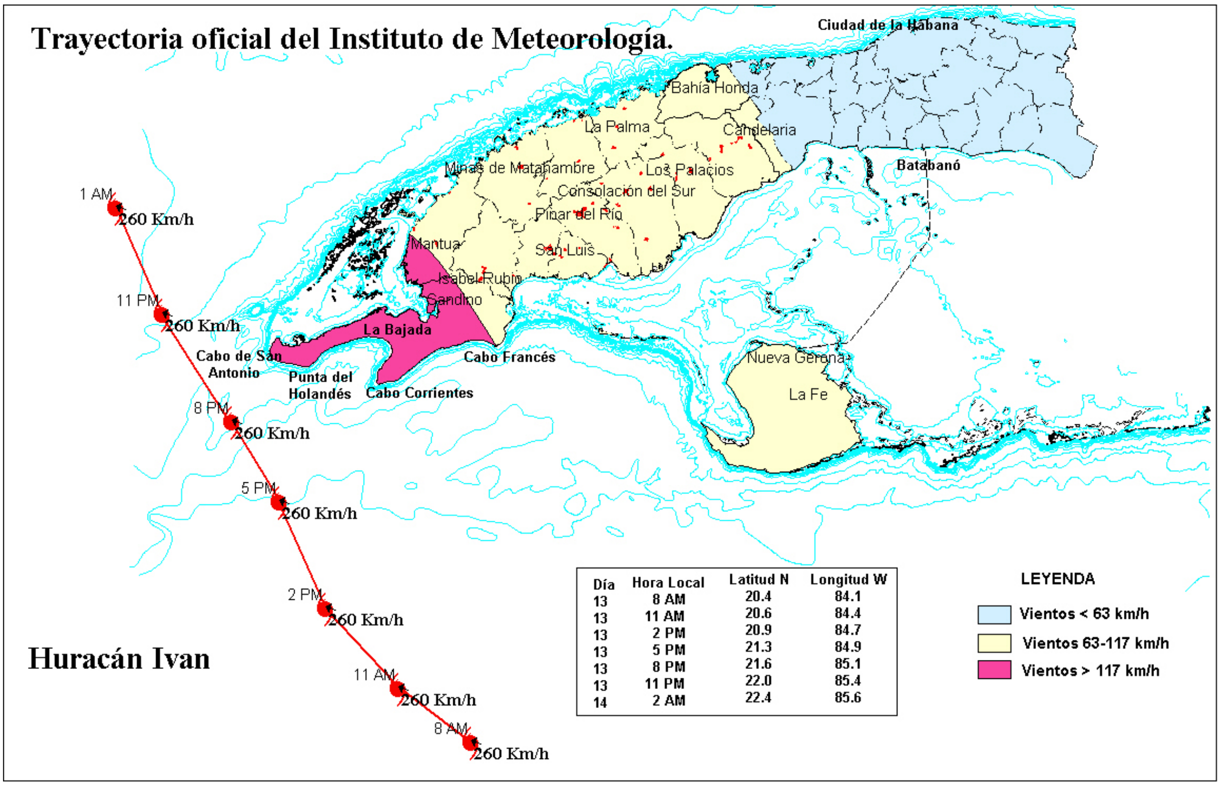


Figura 3

El huracán que se trasladaba al noroeste a razón de 14 kilómetros por hora inclinó en la tarde su rumbo al norte - noroeste con una velocidad de traslación de 15 kilómetros por hora. Tenía vientos máximos del orden de los 260 kilómetros por hora y la presión mínima descendió hasta los 910 hPa, según reportó un avión de reconocimiento a las 4:53 PM (20:53 UTC).

El centro geométrico del ojo tuvo su distancia más cercana a Cuba a las 9:30 PM hora local de verano (01:30 UTC del día 14) a unos 23 kilómetros al oeste – suroeste de Cabo de San Antonio, extremo occidental de Cuba. En la Figura 4 se muestra al patrón nuboso asociado a Iván en el momento en que la pared derecha del ojo influía sobre el extremo occidental de Cuba. La presión mínima central entonces era de 914 hPa y mantenía la misma intensidad de sus vientos máximos. En la estación meteorológica de Cabo de San Antonio sólo el borde externo de la pared del ojo estuvo situado por breve tiempo.

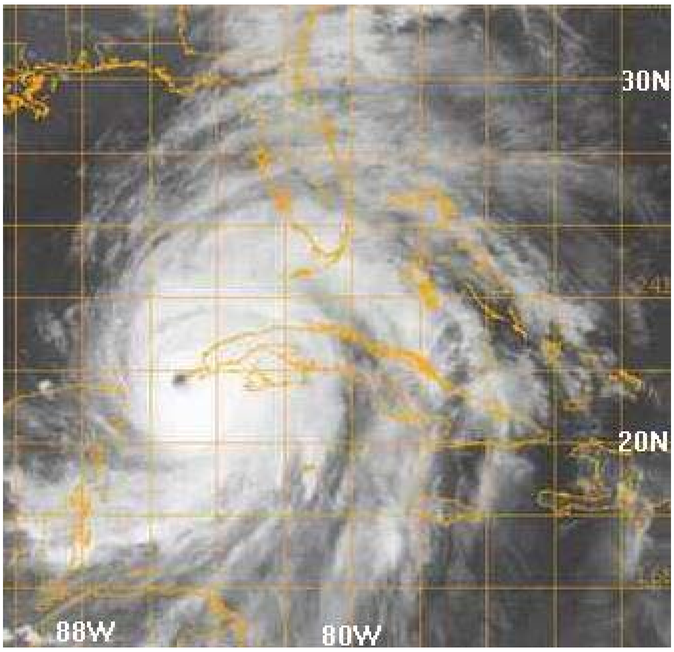


Figura 4

La torre del instrumento registrador de viento instalado en esa estación meteorológica no resistió los fuertes vientos del huracán y se dañó por una fuerte racha de valor desconocido a las 8:50 PM (00:50 UTC del día 14). El instrumento registró antes de averiarse una racha de 192 kilómetros por hora a las 8:30 PM (00:30 UTC del día 14) y vientos máximos sostenidos, promediados en un minuto de 178 kilómetros por hora. El análisis del campo de viento permitió calcular para el Cabo de San Antonio un viento máximo sostenido en un minuto de 215 kilómetros por hora con una racha máxima de 270 kilómetros por hora en el momento de mayor acercamiento del ojo del huracán.

Los datos registrados en la red de estaciones meteorológicas de Cuba llevados a promedio de un minuto, así como los calculados del campo de viento medidos por los aviones de reconocimiento, muestran que los vientos con fuerza de huracán llegaron hasta una distancia de 90 kilómetros al este de Cabo de San Antonio (línea Cabo Francés, Sandino, Arroyos de Mantua), mientras que los de fuerza de tormenta tropical llegaron hasta 225 kilómetros al este de Cabo de San Antonio (inmediaciones de Candelaria). Desde este punto hasta unos 16 kilómetros al este, aproximadamente hasta la Punta del Holandés por la costa sur, afectaron vientos sostenidos entre 185 y 215 kilómetros por hora, lo que corresponde a la fuerza de un huracán intenso. En esa zona se produjeron afectaciones severas en el sistema ecológico.

En la Tabla 6 se presentan los vientos máximos sostenidos y rachas registradas en las estaciones meteorológicas de la Isla de la Juventud y Pinar del Río.

El paso del huracán por el área de Cuba generó lluvias intensas (acumulados superiores a los 100 milímetros en 24 horas) en la Isla de la Juventud, Pinar del Río, La Habana y en aisladas localidades de Ciudad de La Habana (ver Tabla 7). El máximo acumulado de 338.6 milímetros lo reportó la estación meteorológica de Isabel Rubio (Pinar del Río), la más próxima al centro de Iván.

La mar de leva asociada a Iván, cuando éste pasaba por los mares al sur de Jamaica en la noche del 10 de septiembre y el día 11, produjo inundaciones costeras por penetraciones del mar en zonas bajas de las costas de Santiago de Cuba y Granma. De igual forma el día 12 en Cienfuegos las olas alcanzaron hasta 5 metros de altura, ocasionando inundaciones costeras. En Cayo Largo del Sur se calcularon olas entre 5 y 6 metros de altura. En la costa sur de la Isla de la Juventud y las playas que se encuentran en la costa este se produjeron inundaciones costeras por penetraciones del mar, al igual que en las zonas bajas de la costa sur de la región occidental de Cuba.

La altura de la surgencia calculada para la costa sur de Pinar del Río, desde La Coloma hasta el Cabo de San Antonio, estuvo en el rango de 1.8-3.7 metros, correspondiéndole el máximo a La Bajada.

Iván al encontrarse el día 14 sobre el Golfo de México, también ocasionó ligeras inundaciones costeras en el Malecón de Ciudad de La Habana debido a la mar de leva.

Tabla 3. Vientos máximos sostenidos (estimados) en km/h (promedio en un minuto) y rachas máximas registradas en algunas estaciones cubanas al paso de Iván cerca de Cuba los días 13 y 14 de septiembre de 2004.

No. Estación	Localidad	Viento Máximo Sostenidp (km/h)	Racha Máxima Registrada (km/h)
78321	La Fe	94	118
	Nueva Gerona	102	128
78309	Cuba - Francia	83	103
78324	Punta del Este	90	112
78313	Isabel Rubio	112	140
78312	Santa Lucía	112	140
78314	S. J. Martínez	87	109
78316	La Palma	90	112
78315	Pinar del Río	99	124
78317	P.R.S. Diego	78	97

Tabla 4. Mayores acumulados de lluvias registrados en 24 horas (12:00 UTC día 13 – 12:00 UTC día 14) al paso de Iván cerca de Cuba.

Localidad y Provincia	mm/24 horas
Cuba – Francia, Isla de la Juventud	258.0
Nueva Gerona, Isla de la Juventud	153.8
La Fe, Isla de la Juventud	149.0
Punta del Este, Isla de la Juventud	120.7
Isabel Rubio, Pinar del Río	338.6
Pinar del Río, Pinar del Río	195.3
Santa Lucía, Pinar del Río	152.3
San Juan y Martínez, Pinar del Río	144.6
Paso Real de San Diego, Pinar del Río	140.9
La Palma, Pinar del Río	112.5
Surgidero de Batabanó, La Habana	210.4
Mariel, La Habana	202.3
Batabanó, La Habana	182.6
Cayajabo, La Habana	139.8
Las Canas, La Habana	139.0
Artemisa, La Habana	132.7
San Antonio de las Vegas, La Habana	113.0
Punta Brava, Ciudad de La Habana	110.5

Iván resultó ser un huracán tan peligroso con una trayectoria por el sur y próximo a Cuba, que obligó a tomar todo tipo de medidas de protección. Fueron evacuadazas 2 266 068 personas. Hubo gran daño a la agricultura, la electricidad y los teléfonos, así como en las viviendas. En áreas cercanas a Santiago de Cuba, en la región oriental de Cuba, las lluvias provocaron deslizamientos de tierra. Las pérdidas materiales se estimaron en 1 223 millones de dólares estadounidenses. No hubo ninguna muerte.

REPORTS OF HURRICANES, TROPICAL STORM S, TROPICAL DISTURBANCES AND RELATED FLOODING DURING 2004

(Submitted by the Dominican Republic)

INTRODUCTION

The 2004 cyclone season can be categorized as active for the Dominican Republic with a direct hit in the eastern part of the country by Hurricane *Jeanne.* On 16-17 September, *Jeanne* moved over the whole northern coast, parallel to the Cordillera Septentrional, leaving close to Monte Cristi and during its passage caused serious damage to agriculture, roads and railways, major floods on rivers and streams, damage to tourist infrastructure, power supply problems, etc.

The powerful Hurricane *Ivan* passed about 530 km south of the city of Santo Domingo and most of the damage was caused by strong breakers along the whole coast of the Dominican Republic.

Hurricane *Frances* passed close to the northern coast and the strong waves associated with the system caused damage to housing in the NE and erosion of the coastal zone along the lowest beaches on the northern coast.

HURRICANE *JEANNE*

Background

Hurricane *Jeanne* hit the Dominican Republic on 16-17 September 2004, having originated from an easterly wave which turned into Tropical Depression No. 11 late on Monday 13 September some 110 km ESE of Guadalupe. The maximum sustained wind was 25 knots and the minimum central pressure 1010 hPa.

The tropical depression reached the category of tropical storm at midday on Tuesday 14 September, about 550 km from Cabo Engaño (Dominican Republic). Minimum central pressure was 1006 hPa and maximum sustained wind 35 knots.

During the afternoon of Wednesday 15 September Tropical Storm *Jeanne* was affecting the island Puerto Rico about 200 km SE of Cabo Engaño. Minimum central pressure was 991 hPa and maximum sustained wind 60 knots.

In the night of Wednesday 15 September Tropical Storm *Jeanne* started leaving Puerto Rico, moving westwards at 17 km h^{-1} with minimum central pressure of 993 hPa and maximum sustained wind of 55 knots.

Hurricane *Jeanne* (16-17 September 2004)

In the morning of Thursday 16 September, Tropical Storm *Jeanne* entered the Canal de la Mona with favourable conditions for intensifying into a hurricane. At 2.50 a.m., winds in the order of 32.71 m s^{-1} were recorded at Cabo Engaño, at 4.30 a.m. 3.12 m s^{-1} and at 6.40 a.m. 35.74 m s^{-1}, which meant that Tropical Storm *Jeanne* had already become Hurricane *Jeanne*, category 1 on the Saffir/Simpson scale.

During the passage of Hurricane *Jeanne* over the Canal de la Mona winds of hurricane and tropical storm strength were felt throughout the eastern coast of the Dominican Republic. At Punta Cana International Airport, air pressure dropped to 988 hPa.

An extensive cloud field, precipitation and stormy and hurricane-force winds were recorded in the eastern part of the country, with the resultant moderate to heavy rain and intense winds in the main provinces in the NE, E and SE of the country (see rainfall analysis for 16-18 September on page 17).

Hurricane *Jeanne* started moving slowly over the country (see figure below showing the track on 16-17 September 2004). At midday on Thursday 16 it was in the NE of the country.

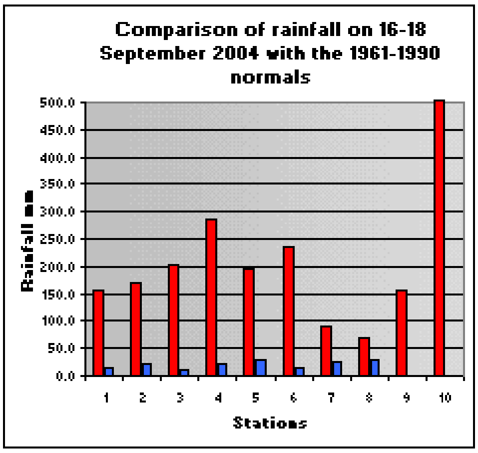
During the afternoon, it degenerated into a tropical storm. The meteorological station Arroyo Barril recorded NE winds of 46 km h^{-1} at 6.00 p.m. (2200 UTC), after which there was a calm, then at 10.20 p.m. (0220 UTC) winds of 87 km h^{-1}. The system continued moving WNW at 9 km h^{-1} the maximum wind dropping to 60 knots and minimum central pressure rising to 990 hPa.

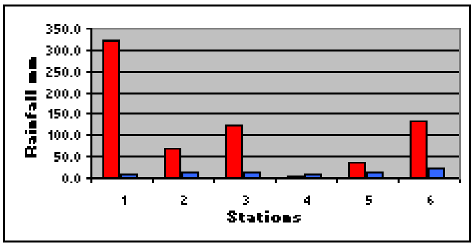
Hurricane *Jeanne* continued moving slowly over the NE and N part of the country until, in the afternoon of Friday 17 September, it left the Dominican Republic in the vicinity of Monte Cristi in the NW of the country, degenerating into a tropical depression some 30 km NW of Monte Cristi over the Atlantic Ocean.

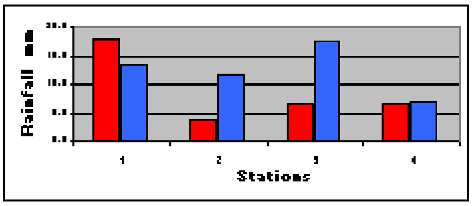
Although Hurricane *Jeanne* only reached category 1 on the Saffir/Simpson scale (and this intensity only lasted for six hours), during its passage over the Dominican Republic, it caused torrential rainfall, very intense winds, big floods and river flooding, collapse of bridges, roads cut off, damage to agriculture, floods in towns, mud slides in outlying parts of towns, interrupted telephone services, power cuts and hundreds of homeless as well as 23 deaths. According to the Economic Commission for Latin America and the Caribbean (ECLAC), the passage of Hurricane *Jeanne* caused losses equivalent to US$ 270 million, i.e. 1.7% of the country's gross domestic product (GDP).

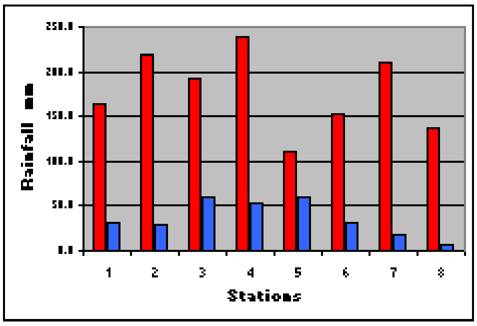
Rainfall analysis during the passage of Hurricane *Jeanne* 16-18 September 2004 compared with the 1961-1990 normals

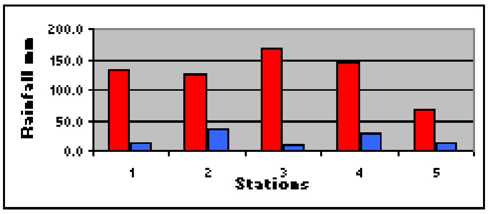
Station / Day	16	17	18	Cumulative mm	Normal	Deviation mm	%
SE region							
1 A. Las Americas	72.2	72.8	12.5	157.5	16.3	141.2	866.3
2 Bayaguana	117.6	34.0	19.1	170.7	21.8	148.9	683.0
3 Punta Cana	117.3	74.6	12.0	203.9	9.2	194.7	2116.3
4 San Rafael del Yuma	163.3	123.7	0.0	287.0	22.2	264.8	1192.8
5 Santo Domingo	118.9	48.3	27.1	194.3	28.9	165.4	572.3
6 San Pedro de Macoris	97.4	35.9	102.2	235.5	14.1	221.4	1570.2
7 Yamasa	56.4	18.8	16.8	92.0	25.9	66.1	255.2
8 Loyola (San Cristobal)	30.0	31.1	6.3	67.4	27.7	39.7	143.3
9 El Seybo	62.0	30.0	62.0	154.0	**	**	**
10 Isla Saona	82.3	366.0	56.9	505.2	**	**	**
SW region							
1 Azua	21.0	50.0	253.0	324.0	8.2	315.8	3851.2
2 Baní	25.5	27.6	14.7	67.8	13.0	54.8	421.5
3 Barahona	1.8	22.8	98.7	123.3	12.8	110.5	863.3
4 Cabral	0.1	3.9	2.7	6.7	8.4	-1.7	-20.2
5 Constanza	32.3	3.1	0.3	35.7	12.9	22.8	176.7
6 Rancho Arriba	21.2	73.9	38.7	133.8	21.4	112.4	525.2
W region							
1 Duverge	0.0	0.0	17.8	17.8	13.3	4.5	33.8
2 Jimaní	0.0	3.1	0.6	3.7	11.8	-8.1	-68.6
3 El Cercado	1.1	5.3	0.0	6.4	17.6	-11.2	-63.6
4 La Descubierta	INAP	6.4	INAP	6.4	6.8	-0.4	-5.9
NE region							
1 Arroyo Barril	122.6	42.1	0.0	164.7	31.8	132.9	417.9
2 Moca	156.0	63.0	INAP	219.0	28.7	190.3	663.1
3 Samana	155.5	30.8	5.5	191.8	59.7	132.1	221.3
4 Sánchez	170.7	68.8	0.0	239.5	52.8	186.7	353.6
5 Sabana de la Mar	89.0	16.7	4.8	110.5	60.6	49.9	82.3
6 Salcedo	105.0	35.9	12.3	153.2	31.5	121.7	386.3
7 Villa Riva	139.9	69.4	INAP	209.3	18	191.3	1062.8
8 La Vega	116.0	22.0	0.0	138.0	7.3	130.7	1790
NW region							
1 Dajabón	17.3	23.6	92.2	133.1	13.3	119.8	900.8
2 Santiago Rodríguez	48.1	79.2	INAP	127.3	34.1	93.2	273.3
3 Villa Vasquez	32.0	123.0	13.9	168.9	11.0	157.9	1435.5
4 Santiago	112.3	33.0	INAP	145.3	28.8	116.5	404.5
5 Monción	36.2	30.0	0.0	66.2	13.5	52.7	390.4
N region							
1 A. la Unión	84.6	141.5	12.8	238.9	13.5	225.4	1669.6
2 Cabrera	173.4	87.0	69.8	330.2	44.0	286.2	650.5
3 Río San Juan	25.4	80.7	0.0	106.1	41.7	64.4	154.4

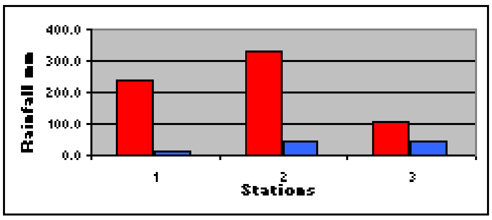










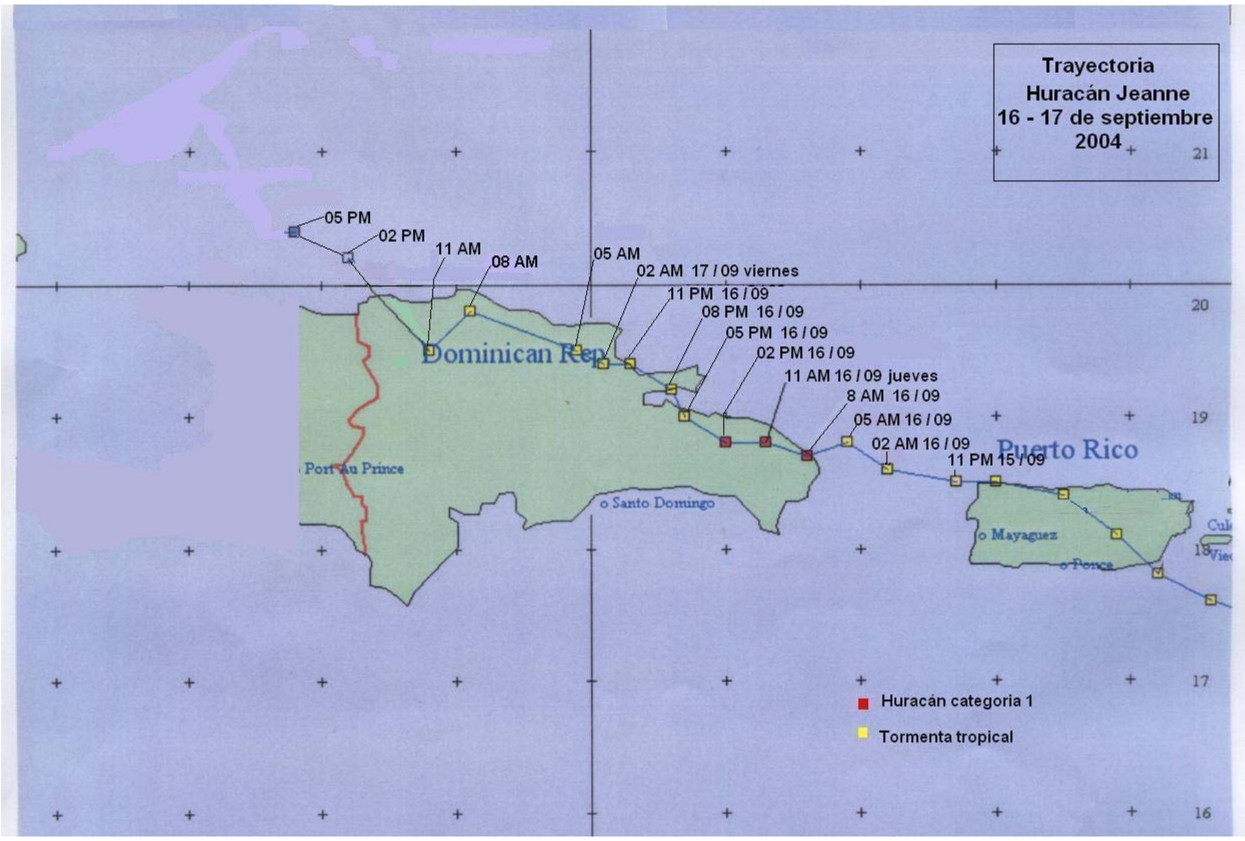


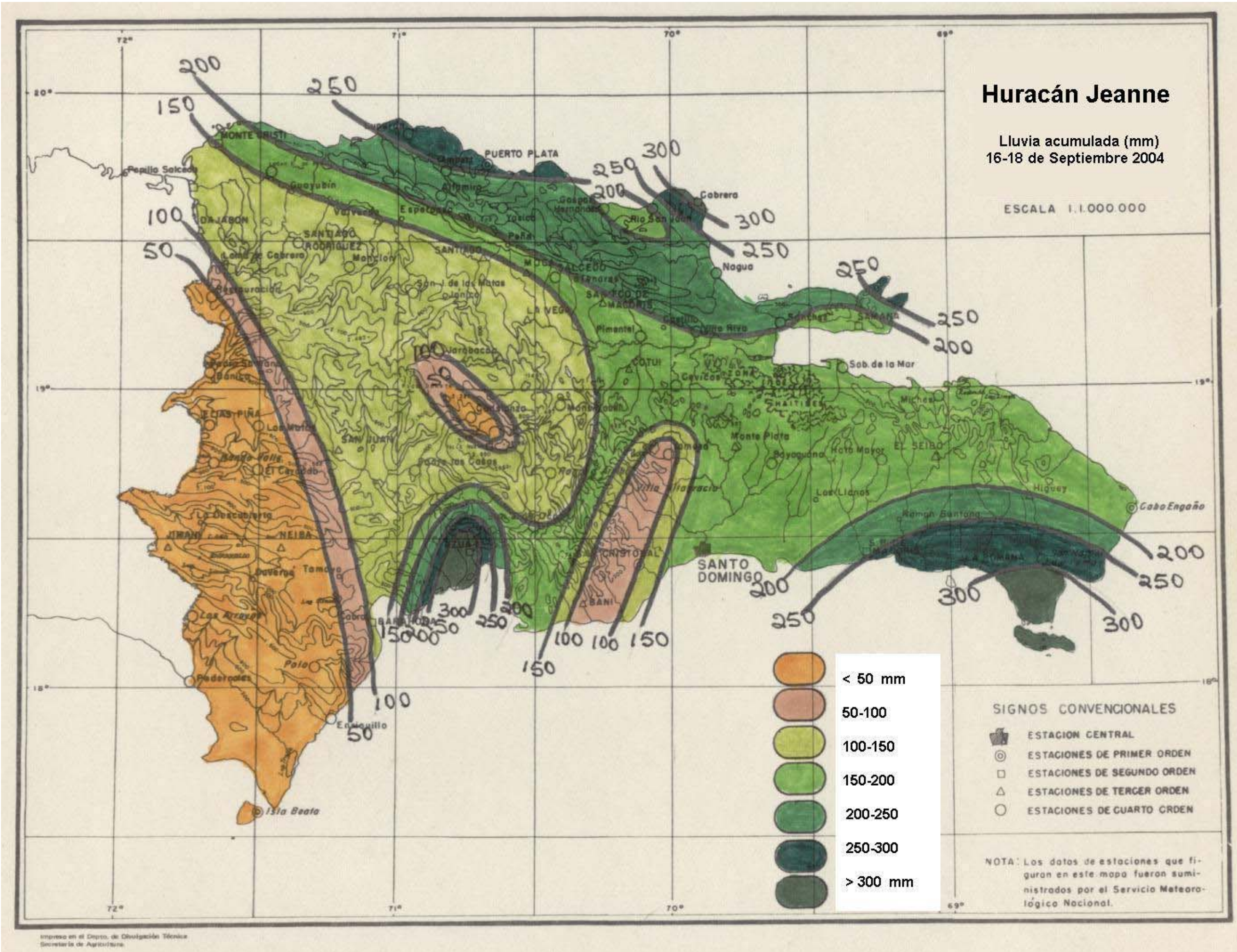
** No normal value exists

Cumulative in mm

Normal

Departamento de Climatología


Trayectoria
Huracán Jeanne
16 - 17 de septiembre
2004
05 PM
02 PM
11 AM
08 AM
05 AM
02 AM 17 / 09 viernes
11 PM 16 / 09
08 PM 16 / 09
05 PM 16 / 09
02 PM 16 / 09
11 AM 16 / 09 jueves
8 AM 16 / 09
05 AM 16 / 09
02 AM 16 / 09
11 PM 15 / 09
Dominican Rep
Port Au Prince
o Santo Domingo
Puerto Rico
o Mayaguez
o Ponce
21
20
19
18
17
16
Huracán categoria 1
Tormenta tropical


Huracán Jeanne
Lluvia acumulada (mm)
16-18 de Septiembre 2004
ESCALA 1:1.000.000
72°
71°
70°
69°
20°
19°
18°
MONTE CRISTI
PUERTO PLATA
DAJABON
SANTIAGO
SANTO DOMINGO
Cabrera
Nagua
SAMANA
Sab. de la Mar
EL SEIBO
Higuey
Cabo Engaño
Isla Beata
< 50 mm
50-100
100-150
150-200
200-250
250-300
> 300 mm
SIGNOS CONVENCIONALES
ESTACION CENTRAL
ESTACIONES DE PRIMER ORDEN
ESTACIONES DE SEGUNDO ORDEN
ESTACIONES DE TERCER ORDEN
ESTACIONES DE CUARTO ORDEN
NOTA: Los datos de estaciones que figuran en este mapa fueron suministrados por el Servicio Meteorológico Nacional.

SUMMARY OF THE 2004 HURRICANE SEASON IN THE FRENCH WEST INDIES (Martinique, Guadeloupe, St. Bartelemy and St Martin)

(Submitted by France)

Despite strong threats, the FWI did not suffer too much from effects of perturbations during the hurricane season as compared with our neighbours.

3 watches and 2 warnings have been issued during the hurricane season.

Watch for TD#2 on August 3rd. Watch on August 29th followed by a warning for St. Bart on August 30th as Frances approached (discontinued on 31st August). Watch followed by a warning for Martinique on September 6th (discontinued on 7th September) as Ivan threatened. The effects of Ivan on Martinique (due to the effects of swell with H1/3 Max up to 4.5m and Hmax up to 6m) was light compared to other islands with some damages in western and southern coastal areas of Martinique and Guadeloupe. No warning was issued for TS Earl (15 August) and DT Jeanne (which gave heavy rain on Guadeloupe, around 300mm).

Heavy rain in October and November caused some flash floods and mud slides (especially in Martinique in November with destruction of some houses) and one casualty in Guadeloupe. Note that the heavy rain in May caused 3 casualties in Martinique.

REPORT ON 2004 HURRICANE SEASON IN ST. LUCIA

(Submitted by Saint Lucia)

Main features

The 2004 hurricane season in our region was one of very high activity. There were fifteen named storms, nine of which became hurricanes and of these, six were major hurricanes. The main effects of this active season locally were:

- Earlier than normal impact of tropical waves(high rainfall).
- Higher than normal rainfall during the period June-August.
- Passage of Hurricane Ivan on 07 September.

Rainfall

The unusually high rainfall prior to the hurricane season caused a premature saturation of the topsoil in many areas. This, combined with the higher than normal rainfall during the early part of the hurricane season triggered several landslides and some periods of flooding. The local Met Office had to issue a number of flood watches and warnings during the months of June and July.

A major landslide in the Tapion, Castries area destroyed three homes in October. Estimated damage from landslides and flooding for 2004 exceeds 1.5 million USD.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall(mm)	65.4	31.4	103.9	121.4	168.0	218.7	187.8	212.9	181.3	180.3	187.7	99.5
31 year mean	70.8	51.1	57.0	57.7	71.1	99.2	149.8	158.1	197.0	198.5	176.7	109.0

2004 Rainfall vs 31year mean for Hewanorra Airport

Tropical cyclone activity

Hurricane Ivan was by far the most significant system to threaten or affect the island. Prior to the passage of Ivan tropical storm watches and warnings had been issued for Tropical Depression #2(03 Aug) and TD #5(14 Aug). Both systems passed without incident.

Hurricane Ivan caused moderate damage mainly due to heavy seas and high winds. The southern part of the island suffered the worst of the damage. Agriculture, in particular the banana industry and coastal infrastructure were the sectors most significantly affected. Damage from Hurricane Ivan is estimated to be 2.6 million USD.

Hurricane Ivan damage in east coast village of Dennery

COUNTRY REPORT

(Submitted by the USA)

The 2004 Atlantic hurricane season was among the most devastating on record. This year's storms claimed 60 lives in the United States and a record loss of $45 billion in property damage, enduring landfalls from five hurricanes (Charley, Frances, Gaston, Ivan, and Jeanne), and the eyewall passage of a sixth (Alex) that avoided landfall on the North Carolina Outer Banks by 10 miles. In addition, Bonnie, Hermine, and Matthew made landfall in the United States as tropical storms. Florida, the "sunshine state", became known as the plywood state after being battered by Charley, Frances, Ivan and Jeanne.

Hurricane Alex

Alex became a hurricane on the 3rd of August when it was centered about 75 miles south-southeast of Cape Fear. Aided by warm Gulf Stream waters and light shear, Alex continued to strengthen during the day as it neared the North Carolina Outer Banks. Alex made its closest approach to land near midday, with its center located about 10 miles southeast of Cape Hatteras, while the western eyewall of the hurricane raked the Outer Banks with sustained category 1 hurricane force winds. During this close approach the hurricane's stronger category 2 winds remained just offshore. In addition to hurricane force winds, the Outer Banks experienced a storm surge of about 6 feet and rainfall in excess of 7 inches. One person died in rip currents associated with the storm. Damage is estimated to be less than $5 million.

Tropical Storm Bonnie

Bonnie was in the central Gulf of Mexico and turned northeastward on August 11, reaching its maximum intensity of 65 m.p.h. later that day. Strong southwesterly wind shear then became established over Bonnie and the cyclone began to weaken. Bonnie made landfall just south of Apalachicola, Florida, during the afternoon on the 12th with 45 m.p.h. maximum winds. After moving inland, Bonnie weakened to a tropical depression and continued to move northeastward across eastern Georgia and the Carolinas. Bonnie produced roughly 30 tornadoes over the southeastern United States, and one of these resulted in three deaths in North Carolina. Bonnie degenerated to a weak area of low pressure near Cape Cod on the 14th.

Hurricane Charley

After making landfall in western Cuba as a category 3 hurricane with 120 m.p.h. Charley's maximum winds decreased to about 110 m.p.h. as the center reached the Dry Tortugas around 8 am on 13 August. Charley then came under the influence of an unseasonably strong mid-tropospheric trough that had dropped from the east-central United States into the eastern Gulf of Mexico. The hurricane turned north-northeastward and accelerated toward the southwest coast of Florida as it began to intensify rapidly and by 10 am, the maximum winds had increased to near 125 m.p.h., and three hours later had increased to 145 m.p.h. - category 4 strength. Charley made landfall with maximum winds near 150 m.p.h. on the southwest coast of Florida just north of Captiva Island around 3:45 pm. An hour later, Charley's eye passed over Punta Gorda. The hurricane then crossed central Florida, passing near Kissimmee and Orlando. Charley was still of hurricane intensity when its center cleared the northeast coast of Florida near Daytona Beach. After moving into the Atlantic, Charley came ashore again near Cape Romain, South Carolina near midday on the 14th as a category 1 hurricane. The center then moved just offshore before making a final landfall at North Myrtle Beach. Charley soon weakened to a tropical storm over southeastern North Carolina and became extratropical on the 15th.

Although ferocious, Charley was a very small hurricane at its Florida landfall, with its maximum winds and storm surge located only about 6-7 miles from the center. This helped minimize the extent and amplitude of the storm surge, which likely did not exceed 7 feet. However, the hurricane's violent winds devastated Punta Gorda and neighboring Port Charlotte. Rainfall amounts were generally modest, less than 8 inches. Charley also produced 16 tornadoes in Florida, North Carolina and Virginia. The total U. S. damage is estimated to be near $15 billion, making Charley the second costliest hurricane in U.S. history. Casualties were remarkably low, given the strength of the hurricane and the destruction that resulted. Charley was directly responsible for ten deaths in the United States.

Hurricane Frances

Hurricane Frances made landfall near Stuart, Florida just after midnight on September 5 with 105 m.p.h. (category 2) maximum winds. The hurricane gradually weakened as it moved slowly across the Florida Peninsula, and became a tropical storm just before emerging into the northeastern Gulf of Mexico early on September 6. Frances made a final landfall in the Florida Big Bend region that afternoon as a tropical storm, weakened over the southeastern United States and became extratropical over West Virginia on the 9th. Frances produced a storm surge of nearly 6 feet at its Florida east coast landfall, and caused widespread heavy rains and associated freshwater flooding over much of the eastern United States, with a maximum reported rainfall of 18.07 inches at Linville Falls, North Carolina. Frances was also associated with an outbreak of over 100 tornadoes throughout the southeastern and mid-Atlantic states. Six deaths resulted from the forces of the storm in the United States. U.S. damage is estimated to be near $8.9 billion, over 90% of which occurred in Florida.

Hurricane Gaston

Gaston reached hurricane strength just before making landfall in South Carolina on the morning of the 29th between Charleston and McClellanville. Gaston weakened as it moved across northeastern South Carolina, becoming a tropical depression late in the day. Gaston moved northeastward over North Carolina and across the Delmarva Peninsula on the 30th, and late in the day re-strengthened to a tropical storm as it moved back over water. Gaston produced widespread flooding across South Carolina, North Carolina, and Virginia, with rainfall totals exceeding 12 inches in the Richmond area, where flash floods killed eight people. The storm generated a 4 foot storm surge at landfall and later produced 14 tornadoes. Total U.S. damage is estimated to be near $130 million.

Tropical Storm Hermine

Hermine reached the southern coast of Massachusetts near New Bedford as a minimal tropical storm on the 31st, and became extratropical shortly thereafter. Hermine brought wind gusts to tropical storm force over eastern Massachusetts. There were no reports of damage or casualties.

Hurricane Ivan

Ivan moved across the east-central Gulf of Mexico, making landfall as a major hurricane with sustained winds of near 120 m.p.h. on the 16th just west of Gulf Shores, Alabama. Ivan weakened as it moved inland, producing over 100 tornadoes and heavy rains across much of the southeastern United States, before merging with a frontal system over the Delmarva Peninsula on the 18th. While this would normally be the end of the story, the extratropical remnant low of Ivan split off from the frontal system and drifted southward in the western Atlantic for several days, and re-entered the Gulf of Mexico on the 21st. The low re-acquired tropical characteristics, becoming a tropical storm for the second time on the 22nd in the central Gulf. Ivan made its final landfall in southwestern Louisiana as a tropical depression on the 24th. Surge heights of 10-15 feet occurred along the Gulf coast during Ivan's first U.S. landfall. Peak rainfall amounts in the United States were generally 10-15 inches. The death toll from Ivan stands at 26 in the United States where the damage is estimated to be near $14.2 billion, the third largest total on record.

Hurricane Jeanne

Jeanne struck Puerto Rico on September 15 with 70 m.p.h. winds. Jeanne moved slowly through and north of the southeastern Bahamas over the next five days while it gradually regained the strength it had lost while over Hispaniola. By the 23rd, high pressure had built in over the northeastern United States and western Atlantic, causing Jeanne to turn westward. Early on the 26th, the center of Jeanne's 60-mile-wide eye crossed the Florida coast near Stuart, at virtually the identical spot that Frances had come ashore three weeks earlier. Maximum winds at the time of landfall are estimated to be near 120 m.p.h. Jeanne weakened as it moved across central Florida, becoming a tropical storm during the afternoon of the 26th near Tampa, and then weakening to a depression a day later over central Georgia. The depression was still accompanied by heavy rain when it moved over the Carolinas, Virginia, and the Delmarva Peninsula on the 28th and 29th before becoming extratropical.

Jeanne produced extreme rain accumulations in Puerto Rico with nearly 24 inches reported in Vieques. These rains resulted in historic floods in Puerto Rico. Three deaths occurred in Florida, and one each in Puerto Rico, South Carolina, and Virginia. In the United States, damage is estimated to be near $6.9 billion.

Tropical Storm Matthew

A weakening Matthew made landfall just west of Cocodrie, Louisiana on October 10 with 40 m.p.h. maximum winds. The weakening system moved inland and was absorbed by a frontal system on the 11th. Matthew's landfall was accompanied by rains in excess of 16 inches, and a 6 foot storm surge that was enhanced by a strong pre-existing pressure gradient in the northeastern Gulf of Mexico. Damage, however, was relatively minor.

Table 1. 2004 Atlantic hurricane season statistics

Name	Class [a]	Dates [b]	Maximum wind (m.p.h.)	Minimum pressure (mb)	Direct deaths (U.S)	U.S. Damage ($ millions)
Alex	Hurricane	31 Jul – 6 Aug	120	957	1	5
Bonnie	Tropical Storm	3 – 13 Aug	65	1001	3	minor[c]
Charley	Hurricane	9 – 14 Aug	150	941	15	15000
Frances	Hurricane	25 Aug – 8 Sep	145	935	6	8900
Gaston	Hurricane	27 Aug – 1 Sep	75	985	8	130
Hermine	Tropical Storm	27 – 31 Aug	60	1002		
Ivan	Hurricane	2 – 24 Sep	165	910	26	14200
Jeanne	Hurricane	13 – 28 Sep	120	950	4	6900
Matthew	Tropical Storm	8 – 10 Oct	45	997		minor[c]

[a] Tropical or subtropical storm: wind speed 39-73 m.p.h. Hurricane: wind speed 74 m.p.h. or higher.

[b] Dates begin at 0000 UTC and include tropical and subtropical depression stages but exclude extratropical stage.

[c] Only minor damage was reported, but the extent of the damage was not quantified.

APPENDIX V

METEOROLOGICAL WATCH OFFICES TO WHICH TROPICAL CYCLONE ADVISORY INFORMATION IS TO BE SENT BY TCAC MIAMI

MWO	ADDRESS
Belem, Brazil	SBBEYMYX
Bogota, Colombia	SKBOYMYX
Caracas, Venezuela	SVMIYMYX
Cayenne, French Guiana (France)	SOCAYMYX
Georgetown, Guyana	SYCJYMYX
Habana, Cuba	MUHAYMYX
Kingston, Jamaica	MKJPYMYX
Mexico, Mexico	MMMXYMYX
Panama, Panama	MPTOYMYX
Port of Spain, Trinidad and Tobago	TTPPYMYX
Port-au-Prince, Haiti	MTPPYMYX
San Juan, Puerto Rico (U.S.A.)	TJSJYMYX
Santo Domingo, Dominican Republic	MDSDYMYX
Tegucigalpa, Honduras	MHTGYMYX
Willemstad, Netherlands Antilles, (Netherlands)	TNCCYMYX
Zandery, Suriname	SMJPYMYX

As well as these addresses:

SADIS Uplink CAR Region	EGZZMCAR
SADIS Uplink SAM Region	EGZZMSAM
OPMET Data Bank, Brasilia	SBBRYZYX
OPMET Data Bank, Washington	KWBCYMYX
WAFC, London	EGRRYMYX
WAFC, Washington	KWBCYMYX

APPENDIX VI

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

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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 2005-2006 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.1.2	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 2005-2006 items with an asterisk to be given priority attention

I. <u>METEOROLOGICAL COMPONENT</u>

TASKS		TIMESCALE 2005	2006	2007	2008	2009	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* Maintenance and replacement of hydrogen generators						Guatemala Venezuela Bahamas	) National and) external) assistance USA	Implemented with the assistance of the USA.
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 2005-2006 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.2.4	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 2005-2006 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.4	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	29 AWS were installed in the Caribbean by the SIDS-Caribbean Project.

I. <u>METEOROLOGICAL COMPONENT</u>

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
1.2.4.3	Establishment of automatic weather stations at the following locations: Bahamas (3) * Dominican Republic (31) Cuba (5) * St. Lucia (4) * Trinidad and Tobago (3) * Mexico (94) * Colombia (185) * Nicaragua (18) * Bermuda (6) Honduras (12)						Bahamas Dom. Rep. Cuba St. Lucia Trinidad and Tobago Mexico Colombia Nicaragua 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. Trinidad and Tobago installed 7 and Honduras installed 3 AWS by the end of 2004.

I. <u>METEOROLOGICAL COMPONENT</u>

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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 Bermuda • Establishment of radar in Bahamas						Barbados, Belice, Trinidad &Tobago Bermuda Bahamas	National and European Union	Being implemented 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						Costa Rica, Nicaragua, El Salvador. Guatemala Venezuela	) National and) external) assistance	CRRH developing a project for Central America

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During 2005-2006 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
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	

* During 2005-2006 items with an asterisk to be given priority attention

I. <u>METEOROLOGICAL COMPONENT</u>

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 POLES 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 2005-2006 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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
		2005	2006	2007	2008	2009			
1.3.3	Regional telecommunication network								
1.3.3.1	Upgrade telecommunication systems in accordance with the RA IV Regional Meteorological Telecommunication Plan,*	______					Members	SIDS Project US, France and VCP	Completed except for X.25 transition to TCP/IP.

* During 2005-2006 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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 2005-2006 items with an asterisk to be given priority attention

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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
		2005	2006	2007	2008	2009			
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	
	• ATRATO, CESAR and SINU basins						Colombia		
	• YAQUE DEL SUR river basin • YAQUE DEL NORTE river basin						) Dominican) Republic		
	• RIO LEMPA						El Salvador and Honduras		Completed
	• OSTUA, COYOLATE, POLOCHIC and MOTAGUA river basins						Guatemala		Completed
	• 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
		2005	2006	2007	2008	2009			
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:								A flash flood warning system was installed in 2003 and 2004 in Central America with support of the USA.
	(b) Establishment of flash flood warning systems in flood-prone areas;						Members concerned	National	
	• St. Lucia						St. Lucia	St. Lucia	
	(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	National	
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
		2005	2006	2007	2008	2009			
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
		2005	2006	2007	2008	2009			
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" (**WMO Secretariat to replace with an IWTC initiative)**						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	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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	
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	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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.

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
3.1 DISASTER REDUCTION									
3.1.1	Drawing the attention of national authorities of the 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 related to natural hazard mitigation						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
		2005	2006	2007	2008	2009			
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 programes 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
		2005	2006	2007	2008	2009			
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 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
		2005	2006	2007	2008	2009			
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	
	Take appropriate steps to organize such training programmes*						Members	National and external assistance	With advice of WMO
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 Desks in Washington and Montreal						Members	National and external assistance	

* During 2005-2006 items with an asterisk to be given priority attention

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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	

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IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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: (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.						Members concerned	National and external assistance	WMO and the USA will be offering a global flash forecasting training course in Costa Rica from 19-23 Sep 2005.
	Courses and workshops on hydrological forecasting techniques or data acquisition, processing and analysis						USA or other Members concerned	National and external assistance	

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2005	2006	2007	2008	2009			
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
		2005	2006	2007	2008	2009			
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 2005-2006 items with an asterisk to be given priority attention.

APPENDIX VII

VCP PROJECTS

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	AEM/3/1/1	Upgrading of the WAFS STAR4 workstation	1998	USA Full	Completed in February 2000: Evaluation Report and Info from USA	US $7,950
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/2/1/2	Provision of 60 rain gauges for Bahama Archipelago	2000	No	No support	
BAHAMAS	OB/2/3/1	Provision of the Automatic Weather Observing Stations (AWOSs)	2000	USA Full	Completed on 31/07/2000: Evaluation Report	$405,000
BAHAMAS	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed in October 2003	US $44,000
BARBADOS	OB/1/3/1	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	On-going	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/2/3/2	Provision of an automatic weather station	2000	USA Full	Completed in June 2000	US $14,000
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	AEM/3/1/1	Upgrading of the WAFS STAR4 workstation for Grenada	1999	USA Full	Completed on 17/01/2000	US $7,950
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	On-going	US $68,500
COLOMBIA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	On-going	US $44,000
COSTA RICA	DP/4/2/1	Improvement of real-time data access at RMTC San José	2003	No	No support	

VCP PROJECTS

Country	Project Indicator	Project Title	Circulation Year	Donor Support	Status of Implementation	Estimated cost
COSTA RICA	HY/1/2/1	Provision of Stevens stream gauges	1999	CANADA Full	Completed in January 2001	US $35,000
COSTA RICA	OB/1/2/10	Provision of upper-air consumables	1999	UK Partial	Completed on 04/04/2000	£33,440
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	On-going	
COSTA RICA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	Completed in March 2004	US $44,000
CUBA	DP/1/2/1	Provision of a PC and a laser printer	1997	VCP(F) Full	Completed on 11/01/2000	$3,000
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	AEM/3/1/1	Upgrading of the WAFS STAR4 workstation	1999	USA Full	Completed on 27/03/2000 (Evaluation Report)	US $7,950
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	On-going	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	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

VCP PROJECTS

Country	Project Indicator	Project Title	Circulation Year	Donor Support	Status of Implementation	Estimated cost
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	On-going	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	On-going	US $44,000
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	On-going	US $110,000
PANAMA	OB/1/3/1	Provision of an electrolytic hydrogen generator and of expert services for its installation	1998	USA Full	Completed in January 2000	US $35,000
PANAMA	TE/2/3/1	Replacement of the RA IV RMTN workstation	2003	USA Full	On-going	US $44,000
SAINT LUCIA	AEM/3/1/1	Upgrading of the WAFS STAR4 workstation	1999	USA Full	Completed on 05/04/2000	US $7,950
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