WORLD METEOROLOGICAL ORGANIZATION

RA IV HURRICANE COMMITTEE

FINAL REPORT

OF THE

TWENTY-NINTH SESSION

CURACAO, NETHERLANDS AND ANTILLES

27 MARCH TO 3 APRIL 2007

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION (Agenda item 1)

As Mr Max Mayfield (USA), Chairman of the Committee, retired as Director of the National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS)/National Hurricane Center (NHC), the Committee decided to elect the new chairman prior to the opening of the session. Mr Bill Proenza (USA), Director of NHC, was unanimously elected as Chairman of the Committee.

1.1 Opening of the session (agenda item 1.1)

1.1.1 At the kind invitation of the Government of the Netherlands Antilles, the twenty-ninth session of the RA IV Hurricane Committee (HC-29) was held in Curaçao, Netherlands Antilles, from 27 March to 3 April 2007. The opening ceremony commenced at 0900 hours on Tuesday, 27 March 2007.

1.1.2 Mr Arthur Dania, Permanent Representative of Netherlands Antilles and Aruba with WMO, welcomed the participants of the RA IV Hurricane Committee (HC). He was pleased to see almost all the Members of WMO Regional Association IV (RA IV) represented at the meeting, as well as several other participants from Spain, Caribbean Institute for Meteorology and Hydrology (CIMH), International Federation of Red Cross (IFRC), International Strategy for Disaster Reduction (ISDR) and Caribbean Meteorological Organization (CMO). He expressed his appreciation that several high-ranking local authorities were present at the opening ceremony. In particular, he thanked the Prime-Minister and Minister of Transport and Communications for their recognition of the importance of the activities of the Committee, and the high priority placed on and strong support of the Government to the Netherlands Antilles to the further enhancement of the National Meteorological and Hydrological Service. He took the opportunity to welcome Mr William (Bill) Proenza, the new Director of the US National Hurricane Center and also new Chairman of the RA IV Hurricane Committee. He thanked WMO and in particular the WMO Secretary-General for their support of the work of the RA IV Hurricane Committee and stressed the need for continued support for the activities of the Committee, in particular to the annual meetings of the Committee. Finally, he wished all the participants an enjoyable stay in Curaçao.

1.1.3 Speaking on behalf of Mr Michel Jarraud, Secretary-General of WMO, Mr Koji Kuroiwa, Chief, Tropical Cyclone Programme Division, expressed his deep appreciation, and that of the World Meteorological Organization, to the Government of the Netherlands Antilles for hosting the twenty-ninth session of the Committee. He emphasized that as the world economy is becoming increasingly sensitive to weather and climate, new and more sophisticated types of meteorological and hydrological services are required by almost every sector of the economy. Noting that WMO's global network has proven to be highly effective for issuing tropical cyclone early warnings, Mr Kuroiwa stressed the RA IV Hurricane Committee is expected to play a vital role in maintaining and coordinating the network on a regional level. He encouraged the Committee to better synergize with other tropical cyclone regional bodies, and regional and international agencies in their efforts towards the mitigation of tropical cyclone disasters. In ensuring WMO's continued support to Committee activities in the region, he wished the session every success.

1.1.4 The Chairman of the Hurricane Committee, Mr Bill Proenza (USA), welcomed all participants and stated he looked forward to a productive session with the active participation of all those attending this years' session.

1.1.5 Mrs Omayra Leeflang, Minister of Education, Sport and Culture for the Netherlands Antilles delivered her opening speech in the presence of the Prime Minister, Mrs Emily De Jongh-Elhage, stressing the importance of the role of WMO and National Meteorological and Hydrological Services in disaster prevention and mitigation and, in particular, the role and work of the RA IV Hurricane Committee. The Minister appreciated the strong spirit of cooperation among the Members of the RA IV Hurricane Committee and strongly endorsed further strengthening of cooperation among the Committee and the Members of the Region. In this connection, she stressed that "We cannot do it alone, but together we can achieve a lot." She emphasized the need for governments and WMO to continue to support strongly the work of NMHSs and the Committee. She thanked WMO and the USA for their strong support in this regard over the years. She also thanked WMO and the Members of Regional Association IV for allowing the Netherlands Antilles to host the twenty-ninth session of the Committee and reminded that in 1994 the sixteenth session took place in Curaçao. She reaffirmed the support of the Government of the Netherlands and Antilles to its own National Meteorological Services and to the work of the Committee. She officially opened the 29th session of the Committee and wished the Committee fruitful deliberations. Finally, she wished all the participants an enjoyable stay in Curaçao.

1.1.6 The session was attended by 56 participants, including those from 24 Members of the Committee, and observers from Spain and four Regional and International Organizations. The list of participants with the capacities in which they attended is given in Appendix I.

1.2 Election of officers

Mr Arthur W. Rolle (Bahamas) was elected as Vice-chairman of the Committee, representing the English-speaking Members of the Committee.

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

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

1.4 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 Mr Max Mayfield retired as Director of the National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS)/National Hurricane Center (NHC)/the World Meteorological Organization's (WMO) Regional Specialized Meteorological Center Miami (RSMC Miami) and Chairman of the WMO Regional Association IV (RA IV) Hurricane Committee in January 2007. Bill Proenza has been selected as the new Director of NHC/ RSMC Miami. In addition to the existing six Senior Hurricane Specialists, four new Hurricane Specialists have joined the RSMC Miami Hurricane Specialist Unit. The positions were divided into two Senior Hurricane Specialists and two Hurricane Specialists. An Executive Officer also joined the NHC to further assist the mission. The names of the four specialists are: Michelle Minelli, Jamie Rhome, Eric Blake and Daniel Brown.

2.2 RSMC Miami experienced a near normal hurricane season in the Atlantic basin and a slightly above average seasons in the eastern North Pacific. RSMC Miami is responsible for tropical and subtropical cyclone advisories for the North Atlantic Ocean, the Caribbean Sea, the Gulf of Mexico and the North Pacific Ocean eastward from 140°W. RSMC Miami continued to assist the RA-IV members in the coordination of watches and warnings during the tropical cyclone events of 2006.

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 Hydrometeorological Prediction Center (HPC) at the National Centers for Environmental Prediction (NCEP) in Camp Springs, Maryland, provides rainfall guidance and serves as the backup for the RSMC Miami. The National Weather Service Storm Prediction Center (SPC) provides general guidance on the possibility of landfalling tornados associated with tropical cyclones with the individual local Weather Forecast Offices providing more specific hazardous weather outlooks (HWOs) and the actual tornado warnings. The Federal Emergency Management Agency (FEMA) Hurricane Liaison Team (HLT) 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 and landfalling threats in the USA from the NHC.

2.4 During the 2006 hurricane season, RSMC Miami began operationally issuing graphical (web) and text products that provide the wind speed probabilities out to five days for 34, 50 and 64-kt to the public. The text product provided probabilities at selected U.S. locations and at sites already provided to RSMC Miami by the WMO RA IV Members. The tropical cyclone wind speed probability text products are found under headers FONT1 11-15 for the Atlantic basin and FOPZ11-15 for the eastern North Pacific basin.

2.5 Also during the 2006 season, Michael Stubbs (meteorologist) and Carl Smith (Emergency Manager) from the Bahamas and Martin Tellez (meteorologist) from Mexico were among the participants in the RSMC Miami attachment programme. The meteorologists helped improve hurricane warning coordination in the region during the tropical cyclone events while they gained valuable training in hurricane forecasting. Mr Smith had a unique opportunity to work with federal, state and local emergency management agencies. He shadowed the FEMA HLT Coordinator at the National Hurricane Center who explained the role the HLT serves in the emergency management community as well as the general roles and responsibilities of FEMA. Mr Smith travelled to Tallahassee and spent two days at the Florida State Emergency Operations Center (EOC). He also visited the Miami-Dade EOC where he met with the staff and had an opportunity to discuss best practices. The Chairman hopes this programme, designed to bring together representatives of both a country's meteorological service and emergency management agency, will foster improved coordination. The RSMC Miami and the WMO strongly encouraged RA IV Permanent Representatives to WMO and the directors of emergency management agencies to nominate candidates for the 2007 season. The Chairman pledged each and every application for the RA IV hurricane attachment programme will be fully considered.

2.6 Three meteorologists from the Mexican Air Force were stationed at the RSMC Miami during 2006. Captain Miguel Angel Lopez Camacho, Major Emigdio Lorenzo Chavez Tejeda and Lieutenant Colonel Eliseo Garcia De La Cruz coordinated timely clearances for hurricane surveillance and reconnaissance flights over Mexico during tropical cyclone events that had the potential to make landfall. Their efforts helped improve the overall efficiency of the Hurricane Warning Programme. The Chairman urges the continuation of this program in 2007.

2.7 The 2007 RA IV Workshop on Hurricane Forecasting and Warning will take place from 16 to 28 April 2007. The workshop will be conducted in English this year. The Chairman strongly believes offering the bilingual workshop every other year is important to the Region's hurricane programme.

2.8 The Latin America-Caribbean Hurricane Awareness Tour (LACHAT) will take place from 16 to 22 April 2007. The U.S. Air Force C-130 (J-model) Hurricane Hunter plane is expected to visit Campeche and Cozumel, Mexico; Grand Cayman Island; Santo Domingo, Dominican Republic; St Croix, US Virgin Islands; and San Juan, Puerto Rico. As in past years, the CHAT is expected to successfully convey the importance of the team effort involved in the hurricane preparedness programme and the need for advance planning in high-risk communities. The CHAT has enhanced the visibility of the participating country's weather forecasting and emergency management offices. Slightly over 12,000 persons toured the plane last year. A Hurricane Awareness Tour (HAT) took place along the U.S. gulf coast from 1 to 5 May 2006. Another HAT is expected to take place along the east coast from 30 April to 4 May 2007.

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

2.10 Radar imagery received operationally at RSMC Miami via the Internet from RA IV Members proved very useful to the RSMC Miami in tracking tropical cyclones. The Chairman encourages Members to continue to make their radar imagery available operationally via the Internet. There has been a major expansion of radar coverage by the U.S. National Weather Service. There is also a new way to depict graphically the radar data. For the first time, radar data will be display velocity and it is GIS-based. The Chairman invited the RA IV Members to view the new product and offered assistance in integrating the new data into their GIS-products.

2.11 Surface and upper-air observations are very important to the operational forecasts of the RSMC Miami. The Chairman appreciated the Members' efforts to maintain their observation and communication systems. Observations from automatic weather stations in the Bahamas, and Mexico and from the Mexican Navy were very useful during several tropical cyclones. Additionally, efforts by the HAM radio operators during the hurricane events were invaluable. Although the Swan Island station is transmitting data, there have been some problems receiving the data at NHC. NWS Telecommunications Operational Center has been alerted to the problem and is investigating. In the fall of 2006, a similar problem existed, but with the help from the vendor experts, NOAA/NWS was able to re-programme the station.

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

2.13 As part of the United States Weather Research Program (USWRP) the Joint Hurricane Testbed (JHT) continues to evaluate research projects with the goal of transitioning successful projects into operations. These projects aim to improve the analysis and forecast of hurricanes. To date 16 projects have been transitioned to operations and 20 additional projects are currently being considered for implementation.

2.14 The Chairman is pleased that eleven WMO/RA IV Members attended the American Meteorological Society (AMS) Annual Meeting in San Antonio, Texas from 13 -19 January 2007. The eleven RA IV members joined colleagues from NMHSs from around the world to participate in the AMS International Sessions on Global Challenges Facing National Hydro-Meteorological Services (NMHSs) and Capacity-Building Workshop on Numerical Weather Prediction (NWP). The international sessions were hosted by the NOAA/NWS Office of International Activities (OIA).

2.15 Lixion Avila is serving as the Chairman of the AMS Tropical Committee until 2008.

2.16 The Sixth International Workshop on Tropical Cyclones (IWTC-VI) took place from 21 to 30 November 2006, in San José, Costa Rica. Lixion Avila represented RA IV on the international organizing committee. Many meteorologists from the Region participated in this very successful workshop. The efforts undertaken by the local organizing committee were greatly appreciated. RSMC La Réunion will likely host IWTC-VII in 2010.

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

2.18 After an exchange of views between Lixion Avila (RSMC Miami) and the staff of the "Instituto Nacional de Meteorologia de Espana", as well as the participation of Spain in the RA IV Hurricane Committee in 2006, the "Instituto Nacional de Meteorologia de Espana" created a small unit of tropical meteorology. The center began issuing special bulletins in close coordination with RSMC Miami when a tropical cyclone was within 1,000 km from Spain. The Institution issued the first advisory during Hurricane Gordon which eventually affected Spain as a strong extratropical system. The Institution also offered to translate some of the RSMC Miami tropical cyclone products into Spanish.

2.19 The Committee requested the update on international activities of the U.S. National Weather Service be moved from the Chairman's Report to Agenda Item 8 Assistance Required for Implementation of the Technical Plan and Strengthening of the Operational Plan.

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

3.1 The Committee noted that the Tropical Cyclone Programme (TCP) continued to give priority to capacity building during 2006. Emphasis was placed particularly on the attachment of forecasters at the different Regional Specialized Meteorological Centres (RSMCs) during the cyclone season and storm surge/wave experts at the Indian Institute of Technology in Kharagpur, India. Joint training events in cooperation with the Public Weather Service Programme such as the RA IV Workshop on Hurricane Forecasting and Warning (Miami, March 2006) and the RA I Training Course on Tropical Cyclones (St. Denis, La Réunion, October 2006) were also stressed with a view to improving media skills of tropical cyclone forecasters.

3.2 The Committee was informed that the study on the economic and social impacts of tropical cyclones has been conducted under Sub-project No. 25 with emphasis on the assessment by end-users of relevant weather services. A detailed pilot study was carried out in the Philippines and the report was submitted to TCP in February 2005. For the following studies to be undertaken in five tropical cyclone regional bodies, arrangements are being made to develop a well-defined methodology for use by both qualitative and quantitative methods.

3.3 The Committee was informed that the Fifth TC RSMC/TCWC Technical Coordination Meeting (Honolulu, December 2005) reviewed the study undertaken by the Systems Engineering Australia Pty Ltd (SEA) to arrive at suitable conversion factors between the WMO 10-minute standard average wind and 1-minute, 2 minute and 3-minute "sustained". It agreed to include a one page executive summary of the study in the Global Guide to Tropical Cyclone Forecasting and in the Operational Plans/Manual of the TC regional bodies in a suitable format. Arrangements are underway with SEA for a further study to produce the one page summary during 2007.

3.4 The Committee was pleased to note that development of the Tropical Cyclone Forecaster web site (TCP Sub-project No. 24), which was implemented in response to a recommendation from IWTC-IV and IWTC-V, has moved into a final stage. The web site will serve as a source for tropical cyclone forecasters to obtain forecasting and analytical tools for tropical cyclone development, motion, intensification, and wind distribution. The test site for the Tropical Cyclone Forecaster website has been developed and is accessible online at the WMO server. The web site will be fully operational before the 2007 cyclone season.

3.5 The Committee noted with appreciation that the Sixth International Workshop on Tropical Cyclones (IWTC-VI) was successfully held in San José, Costa Rica in November 2006. The workshop was organized by AREP in close cooperation with TCP. It brought together operational tropical cyclone forecasters from all the five regional tropical cyclone bodies as well as many researchers, with a view to encouraging the application of research results to operational usage.

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 2006 hurricane season in the Atlantic basin and in the Eastern North Pacific was presented by Dr Lixion Avila, Senior Hurricane Specialist, on behalf of NHC/RSMC Miami

RSMC Miami 2006 Atlantic Hurricane Season Summary

4.1.2 The tropical cyclone activity during the 2006 Atlantic season was near normal, but below the active levels of recent seasons. There were ten tropical storms, five of which became hurricanes, with two becoming major hurricanes (category 3 or greater on the Saffir-Simpson Hurricane Scale). For the 40-year period 1966-2005, the averages for named storms, hurricanes and major hurricanes are eleven, six, and two, respectively. Tropical Storm Alberto and Hurricane Ernesto produced heavy rainfall in portions of the United Sates, Cuba, Haiti, and the Dominican Republic, with the latter responsible for five deaths in Haiti. Florence brought hurricane conditions to Bermuda, and after losing tropical characteristics it also brought hurricane force winds to portions of Newfoundland, Canada. Gordon was the first hurricane to affect the Azores since 1991. In the individual storm descriptions that follow, all dates and times are based on Universal Coordinated Time (UTC).

RSMC Miami 2006 Eastern North Pacific Hurricane Season Summary

4.1.3 After three below-average hurricane seasons, tropical cyclone activity in the eastern North Pacific basin was slightly above average in 2006. Eighteen tropical storms developed, and ten of these strengthened into hurricanes. Five of the hurricanes intensified into major hurricanes (category 3 or stronger on the Saffir-Simpson Hurricane Scale). These totals are above the 1971-2005 mean of 15 tropical storms, nine hurricanes, and four major hurricanes. Not since the 1992 season have as many as 18 tropical storms been observed, and the last time 10 hurricanes occurred was in 1993. Moreover, the 2006 season total of five major hurricanes equals the highest seen since 1998. Three tropical depressions that did not strengthen into tropical storms also formed during the season. The 2006 season featured several landfalls in Mexico, following two quiet years for hurricane strikes. One major hurricane (Lane), one category 2 hurricane (John) and one tropical depression (Paul) made landfall in Mexico during the season.

4.1.4 The summary report on the 2006 hurricane season provided by RSMC Miami is given in Appendix III.

4.2 Reports on hurricanes, tropical storms, tropical disturbances and related flooding during 2006 (agenda item 4.2)

4.2.1 Several Members provided the Committee with reports on the impacts of the season’s tropical cyclones and other severe weather events in their respective countries. With respect to the hurricanes referenced in the summary of the season in both the Atlantic and Eastern North Pacific, the representatives of Antigua and Barbuda, Barbados, Canada, Colombia, Cuba, France, Jamaica, Mexico, Spain, UK (Bermuda), and USA provided the Committee detailed informative reports.

4.2.2 The summary reports on the 2006 season provided by the Members 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 that have an impact on the effectiveness of the Hurricane Warning System.

5.2 As was normal during every session, the Hurricane Committee reviewed the published names of tropical cyclones used in both the Atlantic and the Eastern North Pacific Basins, in case there was any need for changes. It was noted that, in the Atlantic Basin, no major hurricanes made landfall in the 2006 hurricane season and therefore there was no need for changes to the list of names. The representative of the US National Weather Service submitted a request by the RSMC Honolulu, made on behalf of the Hawaii State Civil Defence, for the retirement of a number of names from the list of tropical cyclones in the Eastern North Pacific. The request included names as far back as 1983. The Committee noted that its criteria for the retirement of tropical cyclone names were well defined and very strict. The Committee felt that, while these storms may have had significant impacts on the Hawaiian Islands, none of these impacts were major enough to warrant the retirement of any of the respective names. It noted that the Committee had, in the past, not retired names for systems that had greater impact than those submitted by Honolulu. The Committee therefore declined the request.

5.3 The RSMC, in response to a request, informed the Committee that the flight patterns used by the hurricane reconnaissance aircraft, which had been modified in the Operational Plan in 2004, had thus far provided good results in a very rapid manner.

5.4 The Committee reviewed the new graphic wind speed probabilistic forecast for selected locations on the Atlantic, Caribbean and Eastern Pacific coasts that had been introduced by the RSMC Miami for the 2006 hurricane season. The RSMC Miami indicated that the new product provided improved guidance on the tropical cyclone forecast uncertainties and requested feedback from the NMHSs on the usefulness of the product. As the 2006 hurricane season was below normal in activity, it was felt that a review would be more meaningful after a more normal season. The representative from France felt that the guidance product had particular value in the pre-watch phase, but was not as suitable for detailed planning with emergency officials.

5.5 The representative from France also inquired whether RSMC Miami could include a confidence factor in its bulletins, possibly in the form of a number, which would further assist the NMHSs in their decision-making. RSMC Miami indicated that it had no plans for such a system at this time, but noted that there was a project underway that may attempt to produce such a confidence factor.

5.6 There was considerable discussion on the issuing of “nested” warnings that did not strictly follow the definitions for watches and warnings in the Operational Plan. The main discussion surrounded the decision on whether a hurricane watch or a hurricane warning should be issued for a location when the system had not yet reached hurricane intensity but was forecast to become a hurricane within 24 to 36 hours. The Committee agreed that the final decision on the type and wording of warnings was a national issue, with the Operational Plan as guidance, but reiterated that all warnings should be done in consultation with RSMC Miami.

5.7 In this regard, RSMC Miami reminded the Committee of the need for the warning centres of NMHSs to closely coordinate their warnings with RSMC Miami in a timely manner, and that the coordination could be initiated by either side. In addition, the Committee reiterated how important is was for staff at all NMHSs to be fully familiar with the details of the RA IV Hurricane Operational Plan, in order to avoid coordination problems.

5.8 There was considerable discussion on the perpetual problem of media and other official reliance on advisories and warnings that originate out of RSMC Miami, instead of the well-coordinated warnings issued at the national level. The Committee agreed that this could be addressed by the NMHSs themselves by providing greater information to the media and National Disaster Organizations (NDOs) on the respective roles of RSMC Miami and the NMHSs and how the warnings are coordinated and issued. It was also agreed that, at the national level, the NMHS and the NDO should have a continuous public education programme on tropical storms, hurricanes and the warning system. In addition, NMHSs were urged to continue to tailor their bulletins to add value at the national level.

5.9 The Committee was briefed by RSMC Miami on upcoming changes to its operational products. RSMC Miami indicated that the Tropical Weather Outlook, which has been around for a long time, would be converted into a graphical product, however, the text will remain. The product will be tested in 2007 and made operational in 2008. RSMC Miami also indicated that it would test a new colour graphic product in 2007 to show whether a particular tropical cyclone had a high, medium or low potential for development. The test would be undertaken via the Internet and RSMC Miami requested feedback from the NMHSs on the product. In addition, RSMC Miami informed the Committee that the graphic product depicting the "cone of uncertainty" would be slightly modified from the 2007 hurricane season. The user of the product will be given the ability to toggle the thin black line in the middle of the cone on and off, thereby giving the user the ability to focus on the entire cone instead of the line.

5.10 The Committee noted the need for the establishment of a Hurricane Committee tsunami representative to the IOC International Coordination Group (ICG) Caribbean and Adjoining Regions Tsunami Warning System. Mr Carlos Fuller, President of RA IV, will determine an appropriate point of contact within the Committee and coordinate with that individual. Mr Fuller will also request the Secretary-General of WMO to communicate the Committee's position to and coordinate with the Director General of the UNESCO and ask for a designated focal point from the IOC ICG Caribbean and Adjoining Regions Tsunami Warning System to the RA IV Hurricane Committee.

5.11 The Chairman of the Committee requested the Members to designate a National Tsunami Warning Focal Point to the IOC ICG for 24x7 warning. The following Members have already designated the Focal Point; Antigua and Barbuda, Bahamas, Barbados, Belize, Dominican Republic, Haiti, Netherlands's Antilles and Aruba, and St. Lucia. Those Members not named have not designated a focal point, but it does not mean that they are not involved. However, it would be desirable that they inquire within their nation for a determination of who or what agency will be officially designated as 24x7 National Tsunami Warning Focal Point.

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

6.1 Mr John Parker (Canada) accepted to serve as a coordinator for Attachment 8A (List of telephone number of national services and key officials) to the RA IV Hurricane Operational Plan.

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

6.3 The Committee was informed that the 2006 version of the Hurricane Operational Plan is available online at:

http://www.wmo.ch/web/www/TCP/OperationPlans/TCP30-English2006.pdf

6.4 For the more effective use of the satellite products by Members, the Committee requested the WMO Secretariat to review and update Chapter 5 - "Satellite Surveillance" of the Operational Plan.

6.5 The Committee noted that Chapter 6 - "Aircraft Reconnaissance" should be updated including its coverage and notification of requirements.

6.6 The Committee submitted the amendments to the Plan to the President of RA IV for approval. The Committee urged the WMO Secretariat that the 2007 version of the Operational Plan with these amendments and changes should be posted onto the TCP web site both in English and Spanish as soon as possible. It also requested the Secretariat to distribute the Plan to the Members in WORD format three months before the next session for their careful preparation for the review at the session.

7. REVIEW OF THE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2007 AND BEYOND (Agenda item 7)

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

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

7.1 Meteorological Component (agenda item 7.1)

Global Observing System

7.1.1 The Committee was informed that the Regional Basic Synoptic Network (RBSN) being a minimum regional requirement to permit Members to fulfill their responsibilities within the WMO World Weather Watch (WWW) Programme, continued to provide essential support for hurricane detection and warning services in Region IV. During the intersessional period the number of surface stations in the RBSN decreased by six stations to 535 (541 in 2006) while the number of upper-air stations (136) and automatic marine stations (25) remained unchanged. It should be also noted that during the intersessional period the overall status of implementation of the RBSN remained stable at 90 % for surface observations and 95 % for upper-air observations.

7.1.2 The Annual Global Monitoring (AGM) of the operation of the WWW provides information on the performance level of the observing and telecommunications systems. According to the results of monitoring carried out in October 2006, gaps in the SYNOP data coverage continue to exist over certain areas in the southern part of the Region. The availability of expected SYNOP reports on the Main Telecommunication Network (MTN) from 535 surface stations in the RBSN ranged from 90% at 370 stations (69% of the total, as compared to 66% in 2005) to 'silent' non-reporting at 74 stations (13% of the total, as compared to 9% in 2005).

7.1.3 According to the AGM results in October 2006, the availability of TEMP reports was relatively satisfactory for the northern part of the Region. The availability of expected TEMP reports on the Main Telecommunication Network (MTN) from 136 upper-air stations in the RBSN ranged from 83% at 113 stations (83% of the total, as compared to 82% in 2005) to 'silent' non-reporting at 8 stations (6% of the total, as compared to 5% in 2005). The major difficulties in maintaining reliable implementation of RBSN stations continued to be due to the high cost of consumables and spare parts.

7.1.4 The number of automatic weather stations (AWSs) in the RBSN – RA IV according to information provided by Members in Weather Reporting (WMO-No. 9) Volume A, reached 235 in 2006, compared to 199 in 2004 an increase of 18 per cent within the last 2 years.

7.1.5 The Committee re-affirmed the importance of twice daily upper-air sounding data from Barbados during the months of July through October for that part of the hurricane season. The Chairman noted the need to address this issue of upper air expendables support to Barbados from the NOAA/NWS.

Aeronautical Meteorology

7.1.6 The Committee was informed that Automated Meteorological Reports from aircraft collectively known as Aircraft Meteorological Data Relay (AMDAR) systems continue to represent a prime source of quality, high resolution and timely upper air data. AMDAR data has proved to be vital for improving the accuracy of meteorological forecasts and warnings particularly over data sparse areas. Excellent progress on AMDAR continues to be made. Data counts show that we now have on the average 220,000 automated aircraft reports per day. Comparable numbers were around 10,000 in 1990, 50,000 in 1998, and 100,000 in 2001. In accordance with directions of Congress and the Executive Council, a migration of responsibility for the AMDAR Programme from the Aeronautical Meteorology Programme (AeMP) to the World Weather Watch is underway.

7.1.7 A significant new development, which would complement the already existing wind and temperature data available from AMDAR is the development and testing of a new water vapour sensor, that has been extensively tested in the US and is currently undergoing a performance evaluation in flight trials on Lufthansa aircraft in Europe. First results of this evaluation, after elimination of some technical problems, are very encouraging and show the potential to complement the existing upper air data, and possibly allow some considerable savings if the AMDAR data can replace part of conventional radiosonde ascents. However, the general implementation of these sensors will require a concerted effort on the part of NMHS's to finance the preparation of software, certification and operational deployment of the sensors. A proposal to that effect will be discussed at the forthcoming Cg-XV.

7.1.8 There is also good progress in Region IV with Canadian AMDAR program involving 33 CRJ-200 and 51 DHC8 aircraft from Air Canada. There are plans to include B737 using a proto type based on TAMDAR. West Jet of Canada is also interested in the program with its fleet of 63 aircraft B737-NG. In the US AMDAR program, TAMDAR coverage will continue to expand to 315 airports during 2007. Global System Division (GSD) will continue to study TAMDAR sensor performance and impact on the Rapid Update Cycle (RUC). Data from the current regional fleet has shown a positive impact on RUC temperature, wind and humidity forecasts. NCEP continues to develop improved techniques and web displays for assessing AMDAR data quality and is developing TAMDAR and AMDAR training presentations in both web-based and CD formats. NWS will award a water vapour sensing contract for an initial deployment of 40 units. An expansion will follow.

Meteorological Satellites

7.1.9 The Committee noted that operational or R&D satellites are particularly useful for the detection, monitoring and structure characterization of tropical cyclones and for predicting their evolution. Observations of particular relevance are the permanent high resolution visible and infrared imagery from geostationary spacecraft, microwave sounding from LEO satellites (e.g. with AMSU instrument) to derive total precipitable water, microwave imagery associated with active microwave sensors for precipitation rate (like TRMM and the future GPM), as well as scatterometry, altimetry and/or microwave imagery to derive ocean surface wind fields (e.g. with Quikscat, Jason-1, or METOP/ASCAT). Numerical experiments performed in 2005 also suggest that cloud track wind vectors derived from visible and infrared imagery over the Polar Regions (e.g. from Aqua/MODIS instrument) have a significant impact to improve the accuracy of hurricane track forecasts.

7.1.10 Current constellations of operational geostationary and polar-orbiting meteorological satellites include: GOES-10, GOES-11, GOES-12, NOAA-17 and NOAA-18 operated by the United States; MTSAT-1R operated by Japan; Meteosat-7, Meteosat-8 and METOP-A operated by EUMETSAT; FY-2B and FY-1D operated by China and Kalpana and INSAT-3A operated by India. Additional satellites in back-up position in orbit or in commissioning included GOES-13, NOAA-12, NOAA-14, NOAA-15 and NOAA-16 operated by the United States; Meteosat-6 and Meteosat-9 operated by EUMETSAT; FY-2D operated by China; MTSAT-2 operated by Japan. It should be noted that, following the successful launch and commissioning of GOES-13, the USA have relocated GOES-10 at 60°W in October 2006 in order to provide additional coverage over the Americas. New generation satellites are expected to be launched in 2007, including the polar orbiting FY-3A by China, the polar-orbiting Meteor-M1 and the geostationary Electro-L1 by the Russian Federation, and the geostationary INSAT-3D by India.

7.1.11 Space agencies are also operating a number of environmental R&D satellites that provide a valuable contribution to operational tropical cyclone related activities, in addition to their research or demonstration purpose; in particular, NASA's Aqua, Terra, and QuikScat missions; NASA-CNES Jason-1 mission; NASA-JAXA's TRMM; ESA's Envisat, and ERS-2 missions. There are plans for missions of interest to tropical cyclone monitoring and detection, such as the NASA-JAXA GPM mission, ISRO's Oceansat-2 or the ISRO-CNES Megha-Tropiques and SARAL missions. The relevant agencies have been invited to update and provide to WMO the list of their missions that can be considered as contributions to the space-based global observing system.

7.1.12 It can be recalled that, in response to tropical cyclone monitoring requirements, NASA has agreed to extend the operation of the Tropical Rainfall Measurement Mission (TRMM) until the end of 2009. As concerns the Global Precipitation Measurement (GPM) programme, the launch of its core satellite was postponed until 2013.

7.1.13 The Integrated Global Dissemination Service (IGDDS) project is progressing. One objective of this project is to implement a quasi-global coverage of WMO Regions by multipurpose telecommunications satellite-based broadcasting services using the Digital Video Broadcast (DVB) standard. This international standard, which is not specific to meteorological applications, is widely used by digital television networks. It allows cost-efficient transmission of large data rates and requires very limited investments on the user side. The DVB broadcast services implemented through the IGDDS project and data exchange arrangements between satellite operators should provide the users with access to satellite data from different satellite operators through a single receiving device, along the one-stop-shop concept. Such a service is currently provided by EUMETSAT with its EUMETCAST service that currently covers Europe, Africa, the Americas, and the western part of Asia. An experimental system is implemented by China and there are plans from the Russian Federation. The possibility of a transition from EUMETCAST to a NOAA operated DVB service for meteorological satellite data is being considered. The IGDDS project is aiming to ensure that these different dissemination systems and the associated data exchange arrangements will respond to the WMO requirements and provide access to relevant satellite data on an operational basis.

7.1.14 Training activities in satellite meteorology have culminated in 2006 through the High Profile Training Event (HPTE) that took place from 16 to 27 October 2006. The HPTE included, for the very first time, face-to-face training sessions and Internet-based distance-learning sessions provided throughout the world. More than 2000 persons attended one or more lectures in this period, which involved around 120 out of the 187 WMO Members. Centres of Excellence in Region IV were actively involved in this event through lectures and on-line briefings given from Costa-Rica, Barbados and the USA. The success of this first HPTE was beyond the expectations. There was a strong positive feedback from the attendees and a clear recommendation to repeat such training events, at least at a regional scale.

Marine Meteorological and Oceanography

7.1.15 The Committee was informed that JCOMM had co-sponsored the 9th International Workshop on Wave Hindcasting and Forecasting that took place in Victoria, Canada, in September 2006, which the main theme was 'extreme storm seas'. The '10th International Workshop on Wave Hindcasting and Forecasting & Coastal Hazard Assessment' would be held in North Shore, Oahu, Hawaii, from 11 to 16 November 2007, will have as its focus the 'Improved Predictions of Coastal Hazards'. Moreover, an outline of a Guide to Storm Surge Forecasting has been prepared; the finalization of this Guide is a priority for 2007.

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

7.1.18 The surface buoy network is now essentially complete and needs to be sustained; Argo profiling float programme is 93% complete; the tide gauge network is 40% complete; VOSClim programme which targets a sustained network of some 200 voluntary observing ships delivering high quality observational data for climate related applications is 57% complete. Overall, the ocean in situ observing system is some 56% implemented, with the JCOMM plan moving to full implementation, in principle by 2012. Implementation of the marine observing network in the region has continued to expand. Members in the region are playing a prominent role especially in the Argo project of sub-surface profiling floats to support ocean analysis and global climate studies. Data are made available freely in real-time through Argo GDACs and through the GTS.

7.1.19 The Ninth Intergovernmental Session of the IOC Sub-Commission for the Caribbean and adjacent regions (IOCARIBE) was held in 19 and 22 April 2006 in Cartagena, Colombia. The ICG recognized the WMO-GTS as the backbone global telecommunication mechanism for the exchange of multi-hazards, observations, and information and warnings, including tsunami warnings and alert information. The Terms of Reference for the existing Joint IOC/WMO/CPPS Working Group on the Investigations of El Niño, were discussed and need to be revised and updated in order to ensure that further cooperation should be established to start producing results in the fields of oceanography and operational meteorology. It was also taken into account that the CPPS Secretariat would be serving as Technical Secretariat for the GOOS Regional

Alliance for the Southeast Pacific (GRASP) and that the CPPS formed part of the Board of Directors of the International Research Centre on El Niño (CIIFEN).

7.2 Hydrologic Component (agenda item 7.2)

RA IV Working Group on Hydrology (WGH)

7.2.1 The Committee was informed that the coordinators of the WGH were appointed by the President of RA IV. This was done during EC-LVIII in June 2005. Because of funding limitations, only the sub-group coordinators attended the planned WG meeting.

7.2.2 The meeting of the working group was held in San Salvador, El Salvador, from 4 to 7 December 2006. As decided in Resolution 13 (XIV-RA IV), the WGH has its work divided in five subgroups:

i) Training and continuing education;
ii) Hydrological warning systems;
iii) Integrated Water Resources Management;
iv) Development of CARIB-HYCOS; and
v) Trans-boundary water resources management.

To have more participants in the meeting of the WGH it has been decided that the last three subgroups have two coordinators. The report of the meeting has been sent to the President of RA IV for his approval. The working group is a subsidiary body of the Regional Association and, therefore, it cannot make decisions. Once the report is approved formally it will be distributed to all Members, to Hydrological Advisers and also members of the working group. (The report of the meeting would be available for the participants to the Committee session.)

7.2.3 In total there are eight coordinators and as the vice-chairman is also one of the coordinators, the core members are eight plus the chairman. Three of the coordinators were not able to attend the meeting. Two of them have sent their representatives and one could not attend at the last minute. However, the other coordinator of the group was able to attend and, therefore, the work plans of the five subgroups were defined and also a reporting system to assure that the progress in the activities is well-monitored and corrective measures could be taken if needed. It is expected that every six months information on the progress will be reported. At the beginning of June the first round of reports would be available.

7.2.4 The coordinator on hydrological warning systems will attend the session and provide additional information. If the Committee is interested in receiving information on the development of the activities every six months, the WGH could provide it.

WMO's Commission for Hydrology (CHy)

7.2.5 As part of the WMO's Quality Management Framework, CHy is preparing a series of manuals. One of these manuals is the Manual on Flood Forecasting and Warnings. Experts from various WMO's regions are contributing to the manual. The experts from Region IV (two from the USA) are expected to define soon when their contributions would be available. Once the experts from the Region inform on their plans, the precise timetable for finalizing the manual would be established.

7.2.6 Once the manual is ready, Members would be supported with training courses on the application of the manual. These training courses would be defined in coordination with the regional coordinator on “Training and continuing education“ mentioned in paragraph 7.1.2.

WMO’s Flood Forecasting Initiative

7.2.7 The activities undertaken in the Flood Forecasting Initiative have the potential to go a long way in fulfilling the objectives of WMO by enhancing close cooperation between the NHS and NMHS in countries. Eight regional workshops organized under it had gathered together meteorologists and hydrologists working in the countries to discuss and address flood forecasting issues jointly. A Synthesis Conference was held in Geneva in November 2006 and the “Strategy and Action Plan for the Enhancement of Cooperation between National Meteorological and Hydrological Services for Improved Flood Forecasting” was recommended for Congress adoption. It identifies the following areas of activities that need to be addressed to improve the overall chain of hydrological forecasting:

(i) strengthening of observing and information systems;

(ii) promoting data exchange at national and international river basin levels;

(iii) improvement of meteorological forecasting practices and products;

(iv) improvement of hydrological forecasting practices and products;

(v) strengthening of institutional coordination, cooperation and integration between NMSs and NHSs;

(vi) strengthening of cooperation and coordination of countries in issues related to flood forecasting and warning;

(vii) promoting training and capacity building in NMHSs;

(viii) formulating technical documentation and guidelines related to flood forecasting and warning;

(ix) supporting disaster management;

(x) addressing climate variability and change in the light of extreme events; and

(xi) demonstrating the value of meteorological and hydrological data, information and products (including forecasts).

7.2.8 The Government of Spain provided support for organizing two regional workshops and supporting the activities on flood forecasting through a network called PROHIMET. Experts from Venezuela and from Costa Rica were involved through this network in supporting projects in two Ibero-American countries. One of the countries is Colombia.

7.2.9 The Committee inquired as to why the International Flash Flood Workshop participants were screened. The Committee was informed that the participants were selected based on criteria and areas of expertise.

Integrated Flood Management

7.2.10 The concept of Integrated Flood Management, which has been promoted through the Associated Programme on Flood management was reported earlier. No new developments can be reported since the last session of the Committee.

7.3 Disaster Prevention and Preparedness Component

7.3.1 The Committee was informed that WMO conducted a country-level disaster prevention and mitigation survey (Country-Level DPM Survey) in 2006 to map and benchmark national disaster risk reduction governance and organizational structures, relevant hazards, NMHSs' capabilities and partnerships, as well as their major gaps and needs to support disaster risk reduction decision processes. In this survey, most Members at risk to tropical cyclones have indicated that they could benefit from strengthening the integration of the warnings issued by the NMHSs into emergency preparedness and operations and indicated that they would benefit from advice and support in this area. Those countries are seeking assistance of WMO in this regard.

7.3.2 The Committee noted that there are a number of good practices in which warnings of tropical cyclone and related hazards issued by NMHSs are integrated into emergency preparedness and response planning and operations, supported by governance, legislation and organizational mechanisms, from local to national levels. Through the tropical cyclone regional bodies, these good practices may be identified and documented with assistance of the WMO Natural Disaster Prevention and Mitigation Programme, and shared among all NMHSs in countries at risk to tropical cyclones and related hazards.

7.3.3 The Committee noted that warnings of tropical, storm surge, coastal floods and tides usually are decentralized, falling on responsibilities of different agencies at national level. The decentralization of information presents significant challenges to decision-makers to assess risks associated with situations where tropical cyclones produce storm surges, tides and coastal flooding. To this end, in some countries, NMHSs, together with other technical agencies (e.g. hydrological services, ocean services), have combined their information into information portals to facilitate access by the decision-makers and emergency operators. Based on lessons learned through those good practices, close collaboration among these agencies could be strengthened to ensure that information is available, authoritative, timely, understandable, and easily accessible for emergency operators and decision makers.

7.3.4 The Committee noted that the ongoing United Nations Humanitarian Reform is shifting the paradigm of disaster risk reduction from post-disaster response and recovery towards a more balanced approach with stronger emphasize on prevention and preparedness. In this regard, the Office for Coordination of Humanitarian Affairs (OCHA) is responsible for the coordination of humanitarian activities when international attention is needed to assist countries in disaster situations, and facilitates information to all potential actors for emergency response and preventive measures when hazards are detected and forecasted. Their contingency planning is based on development of risk scenarios, to ensure their timely response when a country seeks assistance and before the disaster affects communication means.

7.3.5 Currently, many of those agencies are not directly linked to the network of NMHSs (i.e. access to official warnings) and RSMCs (i.e. access to specialized forecasts and bulletins). In many cases, they primarily rely on information sources such as international media and miscellaneous academic websites to develop their risk scenarios and contingency plans. Through strengthened partnerships with NMHSs and TC RSMCs, regional and international humanitarian agencies could systematically benefit from more timely and reliable information from the TCP network. Furthermore, through proactive participation of these agencies in the Tropical Cyclone / Typhoon Committees, regional operational plans in support of humanitarian contingency planning and response could be considered, based on better understanding of these agencies' requirements.

7.3.6 Such linkages could be implemented through a network of focal points within these agencies, TC RSMCs and tropical cyclone regional bodies, with support from TCP, DPM Programme Office, and other relevant Programmes Departments within the WMO Secretariat.

7.3.7 The Committee noted that during the Second World Conference on Disaster Reduction (Hyogo, Kobe, Japan, 18-22 January 2005), 168 countries adopted the Hyogo Framework for Action 2005-2015 (HFA) and identified five high priority areas of which the second stresses the need for "identifying, assessing and monitoring disaster risks and enhancing early warnings". Risk identification, involving combination of hazard, vulnerability and exposure, provides the evidence base for disaster risk management applications and decision-making.

7.3.8 The preliminary studies of the Global Risk Identification Programme (GRIP), led by UNDP, have identified that many disaster databases exist (e.g. Em-Dat from OFDA/CRED, NatCat from Munich-Re, Sigma from SwissRe, Desinventar from LaRed, and several national databases). Those could be significantly optimized if standardized methodologies for hazard cataloguing, and common standards for identification of the events and for metadata, were available and utilized.

7.3.9 In 2003 and 2004, TCP participated in the development of the global unique disaster identifier number (GLIDE), on the initiative of ADRC and involving a number of agencies. This identifier has been developed to facilitate quality management of databases, avoiding duplicates, enabling inter-operability and linking hazard events with the related disasters, across national borders. The use of this GLIDE number in all databases is intended to provide extended analysis capacities, including relations between hazard events characteristics and their related impacts.

7.3.10 Programmes such as GRIP are considering adoption of GLIDE for standardization of disaster loss data. TCP in collaboration with the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the Commission for Hydrology (CHy), together with DPM Programme Office, could facilitate participation of TC RSMCs and NMHSs involved in analyzing, forecasting and warning of tropical cyclones and related hazards such as storm surge, coastal and riverine flooding in lowland areas, and tide, in the GRIP initiative, for enhancing these global disaster loss databases, particularly through better cataloguing of hazard information.

7.3.11 The Committee noted that in many countries where tropical cyclone warnings have been effectively integrated in emergency preparedness and response operations, interdisciplinary training curricula between operational forecasters of NMHSs and operational response staff have been developed. Through the Country-Level DPM Survey, many NMHSs indicated that they could benefit from these curricula to enhance their partnerships with emergency response and planning structures.

7.3.12 Tropical cyclone regional bodies could assist WMO with compilation of these curricula and development of training programmes which could benefit those Members of WMO through interdisciplinary training workshops and activities.

7.3.13 Mr Yuichi Ono, a representative of UN/ISDR, stressed the importance of the activities of the Committee and expressed a strong need to have a closer collaboration between the NMHSs and National Disaster Management Offices (NDMO) to reduce hurricane risk in a comprehensive manner by applying the Committee as a portal to discuss the issue. As a first step, he proposed that UN/ISDR could assist inviting the NDMOs in the region to jointly organize a workshop during the annual session of the Hurricane Committee in the future. He made an announcement on the first session of the Global Platform for Disaster Risk Reduction to be held in Geneva, 5-7 May 2007 and encouraged the Members to participate in the session.

7.4 Training Component (agenda item 7.4)

7.4.1 The Committee noted that its Members had benefited from WMO's education and training activities, relating to a number of training courses, workshops, seminars, the preparation of training publications, and the provision of advice and assistance to Members.

- Training Workshop on Hurricane Forecasting and Warning, and Public Weather Services, Miami, 6-8 March 2006;
- Sixth WMO International Workshop on Tropical Cyclones, San José, 21-30 November 2006;
- Seventh Congress on Marine Sciences, Mar, Cuba, 4-8 December 2006;
- Ibero-American Symposium on Flooding and Natural Disasters, Antigua, Guatemala, 5-9 January 2006.

7.4.2 The Committee noted that fellowships for long-term and short-term training totalling 109.5 person x months were granted to the Member countries of the Committee under the various WMO programmes. It further noted with satisfaction the continued efforts being made to enhance the WMO fellowships programme and urged its Members to continue to utilize more effectively this programme. The Committee was informed that the new Fellowship Nomination Form, which could be accessed from the Education and Training Department website, should be used when requesting WMO fellowship.

7.4.3 The Committee encouraged greater contribution of its Members in various education and training activities supported under WMO Voluntary Cooperation Programme (VCP), Trust Fund, UNDP and TCDC arrangements.

7.4.4 The Committee expressed its gratitude to all those Members who made available their training facilities and/or experts to other Members under bilateral or other type of arrangements. It strongly recommended that such endeavours should continue in the future and be strengthened. The Committee urged its Members to make maximum use of such training facilities.

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

7.4.6 The Committee commended the WMO Secretariat for supporting a greater number of fellowships in the Region in 2006. However, the process is not transparent and very slow. The Committee requested the WMO Secretariat to look for ways to streamline the process. It thanked the major donor countries who support VCP, particularly the USA and Canada.

7.5 Research Component

7.5.1 The Committee was pleased to note that the Sixth WMO International Workshop on Tropical Cyclone (IWTC-VI) was successfully held in San José, Costa Rica from 21 to 30 November 2006 with Prof. Johnny Chan and Mr C.Y. Lam (both from Hong Kong, China) as co-chairmen of the International Committee (IC). It was attended by 125 tropical cyclone experts from 34 WMO Members with the Hurricane Committee being represented by its chairperson, Mr Max Mayfield, vice-chairperson, Dr José Rubiera and 23 operational forecasters. Forty-two tropical cyclone research experts from the region, mostly from the USA, also attended the workshop. The proceedings of the workshop are currently being finalized and will subsequently be distributed to the participants and to Hurricane Committee Members. Included in the proceedings are a number of very important and useful recommendations, formulated by the participants and addressed to the WMO Secretariat, to NMHSs and to the research community. Towards the conclusion of the workshop, the participants adopted the Statement on Tropical Cyclones and Climate Change which is available online at: http://www.wmo.int/arep/arep-home.html.

7.5.2 The Committee was informed that the WMO/CAS Working Group on Tropical Meteorology Research was held in Guangzhou, China, from 22 to 24 March 2007. The meeting reviewed the recent developments on tropical meteorology research and discussed future strategies of the working group. Members of the said working group and Prof. Russell Elsberry (USA) were the participants in the meeting.

7.5.3 WMO's World Weather Research Programme (WWRP) organized an International Training Workshop on Tropical Cyclone Disaster Reduction also in Guangzhou, China, from 26 to 31 March 2007. The training workshop was aimed at providing training and experience on new knowledge gained from recent advances on tropical cyclone research and how best to apply these to operational prediction activities in order to enhance the accuracy and usefulness of tropical cyclone forecasts and warnings. The workshop also enabled participants to be aware of the issues associated with disaster mitigation, such as factors contributing to human and economic losses, conveying forecasting and warning information to stakeholders, users and the general public, evaluating the effectiveness of warning systems, mitigation strategies and community capacity building for disaster reduction. Participants to the workshop were from all of the five tropical cyclone bodies.

7.5.4 The Committee took note of the Dr. Lixion Avila's summary of IWTC-VI. It noted with appreciation that Dr. Avila continues as a member of the International Committee of IWTC.

7.5.5 The Committee felt that a detailed report on the discussions about the THORPEX at IWTC-VI should be provided because NMHSs' role in THORPEX is still not clear. It also noted that a thorough understanding is needed as to how THORPEX meets the Regional requirement. If it is not given in a document, it should be specified.

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-eighth session and considered the plan for future action.

8.2 The Committee expressed its satisfaction that WMO, through the Department of Development Cooperation and Regional Activities Department (DCR), with the support of the WMO Office for North, Central America and the Caribbean (NCAC), 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 WMO/NCAC 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 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 additional funds 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 was implemented in Jamaica and Trinidad and Tobago in 2006 in the first phase, and it is expected be extended later to other NMHS in the Caribbean region if funds are available. 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).

8.4 The new agreement of cooperation between WMO and the Government of Mexico signed in 2005, which included the establishment of a project office in 2006 to support the National Water Commission in achieving integrated, sustainable management of water in Mexico. The areas of cooperation outlined in the agreement include efficient management of water, technical support in the fields of hydrology, meteorology, climate variability and change and their effects on water availability, in particular ground water reserves, prevention of floods will be also another area to be covered. To support all these activities a new project on strengthening integrated water resources (PREMIA) began activities in 2006.

8.5 The WMO is developing a bi-national project on Integrated Flash Flooding System for the Sixaola river basin between Costa Rica and Panama. WMO is executing the project through its Department of Hydrology and Water Resources and with the assistance of the Sub-regional Office.

Regional Activities

8.6 The Committee was informed that:

- A Meeting of Directors of NMHSs of Ibero-American countries was held in Buenos Aires, Argentina in November 2006. The meeting was organized by the National Meteorological Institute of Spain and co-sponsored by WMO. As a result of this meeting and previous similar meetings, the Conference of Directors of Ibero-American NMHSs was created and a Cooperation Programme for meteorology and hydrology for NMHSs of Ibero-American countries was established, which are shared by RA III and RA IV Regions. The programme of cooperation includes, assistance on training, operational meteorology, formulation of projects for the development of NMHSs, Participating countries of RA IV include Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

- WMO continued to collaborate with the various economic and technical organizations in the development and implementation of meteorology programmes and projects in RA IV.

- The radar networking system project funded by the European Union has continued being implemented under the coordination of the CMO. The project will benefit the Caribbean region providing early warnings on hurricanes and severe weather.

- The RAMSDIS System that provides, in real time, high-resolution satellite imagery and products continue its execution with great success. The System is supported by the United States Government and the Universidad de Costa Rica and assisted by the WMO.

- WMO, through the Space Programme Office, and the University of Costa Rica have in operation a Centre of Excellence in meteorological satellites at the University of Costa Rica, and its main activities are to: organize training seminars, update and disseminate satellite methods for image reception, promote the use of satellite information in the NMHSs, disseminate training material and to promote the participation of the focal points of the WMO Virtual Laboratory, in weather discussions in real time.

- At the kind invitation of the Government of the United States of America a series of meetings were convened in Miami, Florida in February 2006 to discuss a protocol to establish a mechanism to enable an NMHS to assist another NHMS in the event it could not perform any or all of its functions because of emergencies, to discuss support to those NHMSs affected by the active 2004 and 2005 Hurricane Seasons, and to draft a Regional Action Plan for RA IV.

Training

8.7 The Committee took note that the WMO, the University of Costa Rica and the University of Oslo have opened a Master Degree Programme in Hydrology with strong distance and computer aided learning components. The programme started with 10 students from Costa Rica, El Salvador, Guyana, Panama and 3 students from the University of Oslo. The creation of a similar e-learning MSc degree in Meteorology is in its earlier stage with participation of students from several RA IV countries.

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

8.9 The RA IV Workshops on Hurricane Forecasting and Public Weather Services took place in Miami, U.S.A, in the first quarter of 2006. These very important workshops are organized on an annual basis at the National Hurricane Centre in Miami, USA, with strong support of WMO and the U.S.A. All Members of RA IV strongly endorse the need for continued support for these workshops.

VCP projects

8.10 In 2006, two VCP project requests were submitted by two Members of the Committee for the replacement of the provision of upper-air consumables and for the rehabilitation of meteorological observing network and in 2007 a request was submitted by Bahamas for the provision of a buoy and its related equipment for the study of waves in marine forecasting. Two Members, El Salvador and Guatemala, recently received support from Spain for the rehabilitation of meteorological observing networks and Bahamas received support from Canada. A total of 31.6 person x month of fellowships of different duration was awarded to fellows within the framework of the VCP. The list of VCP projects for RA IV Hurricane Committee Members is given in Appendix VI.

Assistance to NMHSs

8.11 WMO, through DCR Department and the WMO/NCAC Office have assisted Guatemala in the reformulation of the modernization project for the NMHS. Also WMO, with the assistance of Spain, have been working to rehabilitate the operational capacity of the meteorological and hydrological observing network in Guatemala and El Salvador after Hurricane Stan.

8.12 The DCR Department and the WMO/NCAC Office have continued to assist Members in the implementation of the regional components of WMO scientific and technical programmes. The general level of implementation remained satisfactory; however, there are still areas that require further attention and improvement.

Others

8.13 The Committee noted that CIMH is in the process of developing a calibration laboratory that can be used to service both meteorological and hydrological instruments. However, it is necessary that Members provide a clear indication that they will use the capabilities of the facilities before it is further expanded. CIMH has the technicians to support instrument repair and training. Members, however, are requested to indicate their needs including maintenance and training.

8.14 NOAA/NWS has been engaged in capacity-building efforts within the region. NOAA/NWS IAO supports capacity-building, education and outreach activities in RA-IV through the WMO's Voluntary Cooperation Program (VCP). Many of the projects are in support of the monitoring and warning of hurricanes operations of RSMC Miami, but the activities also support the routine forecasting and operations of NMHSs in the region.

8.15 Annually, IAO supports:

- **CaribWeather.net.** Caribweather.net website is a clearinghouse of Caribbean Island weather forecasts. Visitors to the site can find forecasts for the Caribbean as a whole and for individual countries/islands. A Webmasters training course was conducted in November 2006 in Miami, Florida.

- **NOAA Tropical Training Desk**. NOAA trains six fellows from Central America and the Caribbean each year at the Tropical Desk at the NCEP HPC. Fellows are trained on operational skills, including numerical weather prediction techniques.

- **Data Rescue.** NWS IAO is facilitating data rescue projects in the Americas to improve documentation for long term climate and weather information. The first phase will focus on the rescue of surface observations in Uruguay and the Dominican Republic. NWS and NCDC visited Uruguay in fall 2004. Each country receives a PC, digital camera, and cd-roms. Paper archives are photographed, burned on cd, and mailed to NCDC where they are digitized.

- **Desktop Weather Forecast System**. NOAA, through contract with the Center for Ocean-Land-Atmosphere is working with meteorologists in El Salvador to install a version of the ETA Model designed to run on a relatively inexpensive PC and to train local meteorologists on its use.

- **International Satellite Communication System (ISCS**). A satellite data distribution system operated by NOAA was upgraded to add increased data exchange capacity and a communications protocol that allows greater flexibility for the display and manipulation of meteorological products by end users. The ISCS supports the World Area Forecast System (WAFS).

- **E-Learning Initiative:** NWS is working with COMET and the WMO RA-IV to develop an e-learning MSc program in Meteorology to reconcile the operational and management needs of the NMHSs for advanced training with their staffing issues that do not allow for extended staff absences. Professors' training was conducted in Miami, 26–30 June 2006. The first group of students are completing their preparatory classes through winter 2006/2007. The Masters Degree programme will begin in July 2007.

- **WMO Region IV (RA IV) Regional Climate Center (RCC):** WMO directed each of its six Regional Associations to develop a Regional Climate Center (RCC) based on local needs and priorities. In July 2003, an RA IV *Ad Hoc* Advisory Group met to discuss and advise on development of an RCC. It was determined that the needs of WMO RA IV would best be served by a virtual RCC structure. NOAA's NWS agreed to fund an RCC Pilot Project. The Regional Committee on Hydrologic Resources/ Comité Regional de Recursos Hidráulicos (CRRH) in Costa Rica, was awarded $30K to develop the Central American "node" of a virtual RA IV RCC, and there was an inaugural signing ceremony at the RA IV Meeting in San José, Costa Rica, in April 2005. The pilot project will focus on Central America, but will serve as a prototype for the region. The node approach to a RA IV RCC is being explored because of the varying climate services and products needed throughout the region. Among other applications, the climate services and products will be geared toward decision-support tools.

8.16 NOAA/NWS IAO also has additional projects that support operations in RA IV NMHSs and build the capacity of the region to continue to substantively support NOAA/NWS, RSMC Miami, WMO and the RA IV Hurricane Committee. In the fiscal year 2005, NOAA/NWS received USD 260,000 in hurricane supplemental funds following Hurricane Ivan (2004). In the fiscal year 2006, NWS procured hydro-meteorological equipment for Grenada, Cayman Islands, Bahamas, Jamaica, and Honduras. As of the beginning of the 2006 hurricane season all equipment was installed.

8.17 In FY07, NWS received USD 452,000 in funding from the Department of State in support of the Third Border Initiative (TBI) to leverage the hurricane supplemental funds. NWS IAO has expanded the program to a broader Caribbean Initiative through the use of VCP. Activities are focused on enhancement, renovation, and rehabilitation of the hydro-meteorological monitoring network in the TBI countries, including upper-air and surface observation systems as well and hydro-meteorological and sea-level monitoring networks (i.e., tide-gage networks). Tide gage deployment in the Dominican Republic is an initial step in a larger multi-purpose Caribbean water level system requiring wider national commitments to implement.

8.18 The second component of the TBI project includes implementation of and training on the Emergency Managers Weather Information Network (EMWIN). Emergency managers in the U.S., Pacific, Caribbean, and in other nations have used EMWIN to rapidly respond to tornados, hurricanes and tsunamis. EMWIN is a reliable, priority-driven weather-warning and data-broadcast system, which provides free and rapid dissemination of warnings, forecasts, graphics and imagery that has been in operation for nearly ten years. It is a key component in strengthening emergency preparedness and disaster risk reduction. In the Caribbean region, the primary users will be meteorological services who have warning responsibilities and emergency managers who have disaster mitigation responsibilities. The regional emphasis will be on early warning and dissemination of hurricane-related information for use in decision-making. However, EMWIN has the potential to be part of an integrated multi-hazard early-warning system.

8.19 EMWIN Training, in support of the TBI, will consist of comprehensive training workshops. The first of two training opportunities was conducted at RSMC Miami, 5-9 March 2007. One representative each from the meteorological service and the national emergency management organization of Antigua & Barbuda, Dominica, Grenada, St. Kitts & Nevis, and St. Lucia participated in the training. The second training opportunity will take place later in the Bahamas from 2-6 July 2007 and will involve the other seven TBI countries. The seven countries include: Bahamas, Belize, Dominican Republic, Guyana, Haiti, Jamaica, and Suriname. A strategy to provide training and EMWIN coverage to selected RA IV countries not named above is being developed.

9. SCIENTIFIC LECTURES AND DISCUSSIONS (Agenda item 9)

9.1 The following scientific lectures were presented during the session:

- A Hurricane Climatology for Canada - Mr John Parker (Canada)
- TBI Status and Lessons Learned; EMWIN Expansion Project Implementation and Status; NWS Telecommunication Gateway Re-design; Telecommunication and Data Management Issues - Mr Fred Branski (USA)
- Course on Tropical Cyclone through TV: Increasing Public Awareness to Reduce Disasters by Tropical Cyclone - Mr José Rubierra (Cuba)
- Hurricane Hunter Operations - Lt. Col. David Borsi (USA)
- Atlantic Subtropical Storms – Climatology and Characteristics - Mr Mark Guishard (Bermuda)

9.2 Two half-day workshops were held in conjunction with the meeting of the Committee. The topics were “Influence of Tropical Cyclones on the Tourist Industry in RA IV and “Influence of Tropical Cyclones on the Insurance Industry in RA IV”. Mr Max Mayfield, the former Director of NHC, Mr Andy Newman, tourist expert and Mr. Franklin Nutter, insurance expert, conducted the workshops very successfully with attendance of all the participants of the Committee, as well as many participants of the local tourist sector, insurance sector and emergency management groups.

10. DATE AND PLACE OF THE THIRTIETH SESSION (Agenda item 10)

10.1 The delegate from the United States of America informed the Committee that his country would consider hosting the thirtieth session of the RA IV Hurricane Committee in Orlando in 2008.

11. CLOSURE OF THE SESSION (agenda item 11)

The report of the twenty-ninth session of the Committee was adopted at its final meeting at 1110 hours on 3 April 2007.

LIST OF APPENDICES

APPENDIX I

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APPENDIX II

AGENDA

1. ORGANIZATION OF THE SESSION

   1.1 Opening of the session
   1.2 Election of officers
   1.3 Adoption of the agenda
   1.4 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 2006

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 2007 AND BEYOND

   7.1 Meteorological Component
   7.2 Hydrological component
   7.3 Disaster prevention and preparedness component
   7.4 Training
   7.5 Research

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

9. SCIENTIFIC LECTURES AND DISCUSSIONS

10. DATE AND PLACE OF THE THIRTIETH SESSION

11. CLOSURE OF THE SESSION

APPENDIX III

REVIEW OF THE PAST HURRICANE SEASON

RSMC Miami 2006 Atlantic and Eastern North Pacific Hurricane Season Summary

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

ATLANTIC

The tropical cyclone activity during the 2006 Atlantic season was near normal, but below the active levels of recent seasons. There were ten tropical storms, five of which became hurricanes, with two becoming major hurricanes (category 3 or greater on the Saffir-Simpson Hurricane Scale). For the 40-year period 1966-2005, the averages for named storms, hurricanes and major hurricanes are eleven, six, and two, respectively. Tropical Storm Alberto and Hurricane Ernesto produced heavy rainfall in portions of the United Sates, Cuba, Haiti, and the Dominican Republic, with the latter responsible for five deaths in Haiti. Florence brought hurricane conditions to Bermuda, and after losing tropical characteristics it also brought hurricane force winds to portions of Newfoundland, Canada. Gordon was the first hurricane to affect the Azores since 1991. In the individual storm descriptions that follow, all dates and times are based on Universal Coordinated Time (UTC).

Tropical Storm Alberto formed on 10 June in the northwestern Caribbean Sea from an interaction of a tropical wave with an area of disturbed weather that had persisted in the area for several days. The center of the poorly-organized depression moved northwestward through the Yucatan Channel, and the cyclone became a tropical storm over the southeastern Gulf of Mexico early on 11 June while centered about 100 miles west-northwest of the western tip of Cuba. On 12 June, Alberto turned northeastward and abruptly strengthened, reaching a peak intensity of 70 mph. As Alberto approached the northeastern coast of the Gulf of Mexico that night, it weakened and made landfall near Adams Beach in the Big Bend area of Florida on 13 June with maximum winds of 45 mph. Alberto weakened to a depression early on 14 June over Georgia and then emerged off the mid-Atlantic coast of the United States as an extratropical low-pressure system that night. The system accelerated northeastward and became a powerful extratropical storm just south of Nova Scotia. It passed over Newfoundland and then weakened as it traversed the North Atlantic Ocean, reaching the British Isles before being absorbed by a frontal system on 19 June.

Alberto produced torrential rains across western Cuba. The highest rainfall amount reported was 17.52 inches at Rio Seco, Pinar del Rio. Several additional locations in Pinar del Rio and on Isla de la Juventud received 10 to 15 inches of rain. In the United States, a wide swath of 3 to 5 inches of rainfall occurred over central and northeastern Florida, southeastern Georgia and portions of central South and North Carolina. The largest accumulations were near 7 inches. Only minor damage was reported, with some homes and businesses damaged by storm surge flooding in Levy and Citrus counties in Florida. There were no deaths associated with Alberto as a tropical cyclone.

Unnamed Tropical Storm. As part of its routine post-season review, the National Hurricane Center occasionally identifies a previously undesignated tropical or subtropical cyclone based on new data or meteorological interpretation. This year's review has identified such a system.

The unnamed tropical cyclone originated along the end of a cold front that moved offshore of the northeastern United States late on 13 July. An extratropical low formed along the stalled and decaying front on 16 July about 350 miles south-southeast of Nantucket, Massachusetts, when an upper-level trough approached from the west. The upper trough weakened, and the surface low moved slowly northeastward over warm Gulf Stream waters. The associated front dissipated late on 16 July, and thunderstorm activity increased near the center of the low. By early on 17 July, when the center of the low was about 250 miles southeast of Nantucket, the system had sufficient organization to be considered a tropical depression. The cyclone moved northeastward and strengthened, becoming a tropical storm and reaching its peak intensity of 50 mph later that day. The storm quickly encountered cooler waters, however, and its thunderstorm activity diminished. On 18 July, the system degenerated to a non-convective remnant low. The low moved across Newfoundland, turned toward the east-northeast, and then dissipated on 19 July over the open waters of the North Atlantic Ocean. No reports of damage or casualties from this system were received.

Tropical Storm Beryl originated from the decaying frontal zone that led to the formation of the unnamed tropical storm on 17 July. Beryl first formed as a tropical depression on 18 July about 300 miles east-southeast of Wilmington, North Carolina and strengthened into a tropical storm later that day. Moving generally northward, Beryl passed about 115 miles east of Cape Hatteras and reached its peak intensity of 60 mph on 19 July. Over the next couple of days, Beryl moved toward the north-northeast and northeast with increasing forward speed, passing over Nantucket early on 21 July, where wind gusts to tropical storm force were reported. The weakening storm continued to accelerate northeastward, and Beryl lost its tropical characteristics over western Nova Scotia late on 21 July. The remnants of Beryl merged with another extratropical low the next day. There were no reports of casualties or damage in association with Beryl.

Tropical Storm Chris developed from a tropical wave and became a depression on 1 August about 250 miles east-southeast of the northern Leeward Islands. Moving west-northwestward, the depression became a tropical storm later that day and continued to strengthen, reaching its peak intensity of 65 mph on 2 August a short distance northeast of the northern Leeward Islands. However, strong vertical wind shear then caused Chris to weaken abruptly on 3 August. The system turned westward and weakened to a tropical depression later that day about 225 miles east-southeast of the Turks and Caicos Islands. Chris degenerated into a remnant low early on 4 August and dissipated near the northern coast of Cuba on 6 August. Chris produced heavy rainfall and localized flooding over portions of Puerto Rico, the Dominican Republic, Haiti, and eastern Cuba. Overall, damage was minor and there were no casualties reported in associated with Chris.

Tropical Storm Debby developed from a vigorous tropical wave that exited the west coast of Africa on 20 August. Almost immediately after moving offshore, shower and thunderstorm activity began to consolidate around a broad circulation. Additional development the next day resulted in the formation of a tropical depression in the far eastern Atlantic about 250 miles south-southeast of the Cape Verde Islands. The depression moved west-northwestward, passing about 100 miles to the southwest of the islands on 22 August. Early on 23 August, the depression became a tropical storm about 225 miles west of the Cape Verde Islands, and its winds reached 50 mph later that day. Embedded within a relatively dry and stable air mass, Debby moved west-northwestward with little change in strength over the next couple of days. The cyclone then began to weaken on 25 August due to southerly wind shear. Debby weakened to a depression and degenerated to a remnant low the next day about 1400 miles east-southeast of Bermuda. The low then turned northward and dissipated on 28 August ahead of an approaching frontal system. There were no reports of damage or casualties in association with Debby.

Hurricane Ernesto originated from a tropical wave that moved across the coast of Africa on 18 August. On 23 August, as the wave approached the Lesser Antilles, convection began to increase, and on 24 August a closed wind circulation developed, signaling the formation of a tropical depression about 45 miles north-northwest of Grenada. The depression strengthened to a tropical storm the next day while located over the eastern Caribbean Sea about 300 miles south of Puerto Rico. The storm turned northwestward on 26 August over the central Caribbean Sea and continued to intensify. Early the next day, while centered about 70 miles south of the southern coast of Haiti, Ernesto was briefly a hurricane with maximum winds of 75 mph before weakening abruptly. Weakening continued on 28 August as Ernesto passed very near the southwestern tip of Haiti, and Ernesto made landfall later that day just west of Guantanamo Bay, Cuba with maximum sustained winds of 40 mph.

Ernesto crossed eastern Cuba and emerged off the north-central coast of Cuba early on 29 August. The storm continued northwestward and made landfall in extreme southern Florida early on 30 August with 45 mph maximum winds, and maintained tropical storm status as it moved northward over the southern Florida peninsula. The circulation center emerged over the Atlantic Ocean near Cape Canaveral early on 31 August. Ernesto strengthened over the warm waters of the Atlantic while heading north-northeastward, its winds reaching 70 mph while centered about 175 miles south-southwest of Wilmington, North Carolina. Ernesto maintained this strength until landfall early on 1 September near Oak Island, North Carolina, just west of Cape Fear. It weakened inland and became a tropical depression over North Carolina later that day, and lost its tropical characteristics by late on 1 September as it moved over Virginia. The remnant extratropical low moved slowly northward over Pennsylvania and New York and was gradually absorbed into a larger extratropical system during the following couple of days.

The strongest sustained wind measured by an official surface-based anemometer in North Carolina was 58 mph at the National Ocean Service station at Wrightsville Beach (Johnny Mercer Pier). A wind gust to 74 mph was also reported at this location. At Wilmington a wind gust to 62 mph and a minimum pressure of 985.4 mb were observed. A large area of high pressure centered over southeastern Canada combined with the approaching Ernesto, even prior to its landfall, to produce sustained gale-force winds and some rather heavy rains over and near the coasts of Virginia, Maryland, Delaware, and New Jersey. As the extratropical remnant of Ernesto moved slowly over eastern Virginia and Maryland late on 1 September and on the following day, it was directly responsible for the gale-force winds in those areas. This complex series of events resulted in significant storm surge flooding along the western shores of Chesapeake Bay and the adjacent rivers, where storm tides of up to about 6 feet were reported.
The combination of Ernesto and the high pressure system to its north resulted in a significant rainfall event over the mid-Atlantic coastal regions of the United States. Storm-total rainfall amounts exceeded 5 inches in a broad swath across eastern portions of South Carolina, North Carolina, and Virginia, as well as southern Maryland. More than 10 inches of rain fell at several locations in North Carolina and Virginia, including a maximum amount of 14.61 inches at Wrightsville, Beach. In Florida, 8.72 inches of rain fell near Naples, but most of Florida received much less. In Cuba, a maximum amount of 7.46 inches was observed in Nuevitas, Camaguey. About 7 inches of rain fell at Barahona in the Dominican Republic.

Five fatalities were directly caused by Ernesto, all in Haiti. There were also two fatalities in Virginia associated with strong gradient winds well to the north of Ernesto that occurred when a tree fell on a residence. Many locations in Haiti, the Dominican Republic, and the eastern United States experienced damage due to floods associated with Ernesto's rains. U. S. damage is estimated at $500 million.

Hurricane Florence's development involved the interaction of two tropical waves, one that moved across the west coast of Africa on 29 August and progressed slowly westward, and another that crossed the coast two days later but moved westward at a more rapid rate. On 2 September, the two waves combined to form a large area of disturbed weather over the eastern tropical Atlantic. Convection increased and a tropical depression formed the next day about 1000 miles west of the Cape Verde Islands. The depression was large and not well organized initially as it moved west-northwestward, and the system took two days to attain tropical storm strength. Westerly wind shear continued to limit development until 8 September, when Florence began to strengthen. Florence became a hurricane early on 10 September while centered about 400 miles south of Bermuda. The hurricane turned northward, passing about 60 miles west of Bermuda on 11 September while at its estimated peak intensity of 90 mph. After passing Bermuda, Florence turned northeastward later that day and retained hurricane strength until it became extratropical early on 13 September about 500 miles south-southwest of Cape Race, Newfoundland. As an extratropical low, the cyclone maintained hurricane-force winds as it passed over Cape Race late on 13 September. After passing Newfoundland, the cyclone moved east-northeastward over the open North Atlantic for several days. The extratropical remnants of Florence were absorbed by another low southwest of Iceland on 19 September.

Florence was a large cyclone from its inception through its extratropical stage. Even though its eye passed 60 miles west of Bermuda, Florence brought hurricane conditions to the island. An automated observing station at St. David's (elevation 157 feet) reported sustained winds of 82 mph with a gust to 112 mph. A wind gust to 115 mph was reported at the Bermuda Maritime Operations Centre. Sagona Island, Newfoundland reported sustained winds of 76 mph with a gust to 93 mph. Florence caused widespread power outages and minor damage in both Bermuda and southeastern Newfoundland. A few injuries were reported in Bermuda.

Hurricane Gordon formed from a well-defined tropical wave that crossed the west coast of Africa on 1 September. Westerly shear associated with the outflow of Florence inhibited development initially, but ultimately a depression formed on 10 September about 550 miles east-northeast of the Leeward Islands. The depression strengthened into a tropical storm on 11 September and turned toward the northwest through a weakness in the subtropical ridge associated with Hurricane Florence. Gordon strengthened and became a hurricane early on 13 September, then turned northward and rapidly intensified, reaching its peak intensity of 120 mph (category 3 on the Saffir-Simpson Hurricane Scale) early on 14 September while located about 575 miles east-southeast of Bermuda. An upper-level trough turned Gordon northeastward over the central Atlantic, but the trough bypassed the hurricane and steering currents weakened the next day. Gordon moved little on 16-17 September while it gradually weakened. On 17 September, a building mid-to upper-level high to the east of Gordon began steering the hurricane northeastward, and an approaching upper-level trough reinforced this motion the next day. The tropical cyclone turned toward the east and re-strengthened on 19 September, reaching an intensity of 105 mph about 475 miles west-southwest of the Azores. Moving quickly eastward over slightly cooler waters, Gordon gradually weakened as it approached the Azores. On 20 September, the center of Gordon passed between the Azores islands of Sao Miguel and Santa Maria, and shortly thereafter the cyclone became extratropical about 275 miles west of the coast of Portugal. As a strong extratropical low, Gordon turned northward on 21 September and intensified. The low passed over western Ireland late that day, and then made a large cyclonic loop before dissipating between Ireland and England on 24 September.

The highest wind gust reported in the Azores was 82 mph at Santa Maria. As an extratropical cyclone, Gordon produced numerous hurricane-force wind gusts in northwestern Spain including a wind gust to 114 mph at Punta Candierira. Media reports indicate that damage in the Azores was minor. Minor damage was also reported in portions of Spain, Britain, and Ireland.

Hurricane Helene, the longest-lived tropical cyclone of the 2006 season, developed from a vigorous tropical wave that emerged from the west coast of Africa on 11 September. After exiting the coast, shower and thunderstorm activity quickly became organized and a tropical depression formed the next day about 225 miles south-southeast of the Cape Verde Islands.

The depression passed about 190 miles south of the Cape Verde Islands before strengthening to a tropical storm early on 14 September. Moving west-northwestward over the tropical Atlantic Ocean, Helene steadily intensified and became a hurricane on 16 September while located about 1150 miles east of the northern Leeward Islands. A weakness in the subtropical ridge associated with Hurricane Gordon caused Helene to turn northwestward on 17 September. Helene attained category 3 status and reached its peak intensity of 120 mph on 18 September. As Gordon moved away, a narrow mid-to upper-level ridge built to the north of Helene on 19 September and caused the hurricane to turn westward while it gradually weakened. Helene turned northward on 20 September ahead of a large deep-layer trough that was moving off the east coast of the United States. Helene passed about 550 miles east of Bermuda early on 21 September and then turned east-northeastward over the open waters of the central Atlantic. Helene retained hurricane strength and became extratropical on 24 September about 325 miles west-northwest of the Azores. The extratropical low gradually weakened and passed near northwestern Ireland and Scotland on 27 September. It was absorbed by a larger extratropical low late that day.

There were no reports of damage associated with Helene. As an extratropical low, Helene produced strong wind gusts across much of Ireland and northwestern Scotland. The highest reported wind gust in Ireland was 56 mph at the Valentia Observatory and a wind gust to 74 mph was reported on South Uist Island in the Outer Hebrides of western Scotland.

Hurricane Isaac developed from a tropical wave that exited the west coast of Africa on 18 September, becoming a depression on 27 September about 925 miles east-southeast of Bermuda, and a tropical storm early the next day. Isaac was surrounded by relatively dry and stable air, and waters beneath the cyclone had been cooled by Hurricanes Gordon and Helene; as a result, little development occurred over the next day or so. The cyclone began to strengthen late on 29 September and Isaac became a hurricane on 30 September while centered about 375 miles east-southeast of Bermuda. The hurricane reached its peak intensity of 85 mph on 1 October while passing about 325 miles east of Bermuda. Later that day, Isaac began to accelerate around the western periphery of the subtropical ridge. The hurricane moved quickly north-northeastward on 2 October ahead of an approaching deep-layer trough, weakening as it encountered increasing southwesterly shear and cooler waters. Late on 2 October, the center of Isaac passed about 40 miles southeast of the Avalon Peninsula of Newfoundland, bringing winds of tropical storm force across portions of the southern Avalon Peninsula. Isaac lost its tropical characteristics on 3 October and merged with a larger extratropical low later that day. No reports of damage were received.

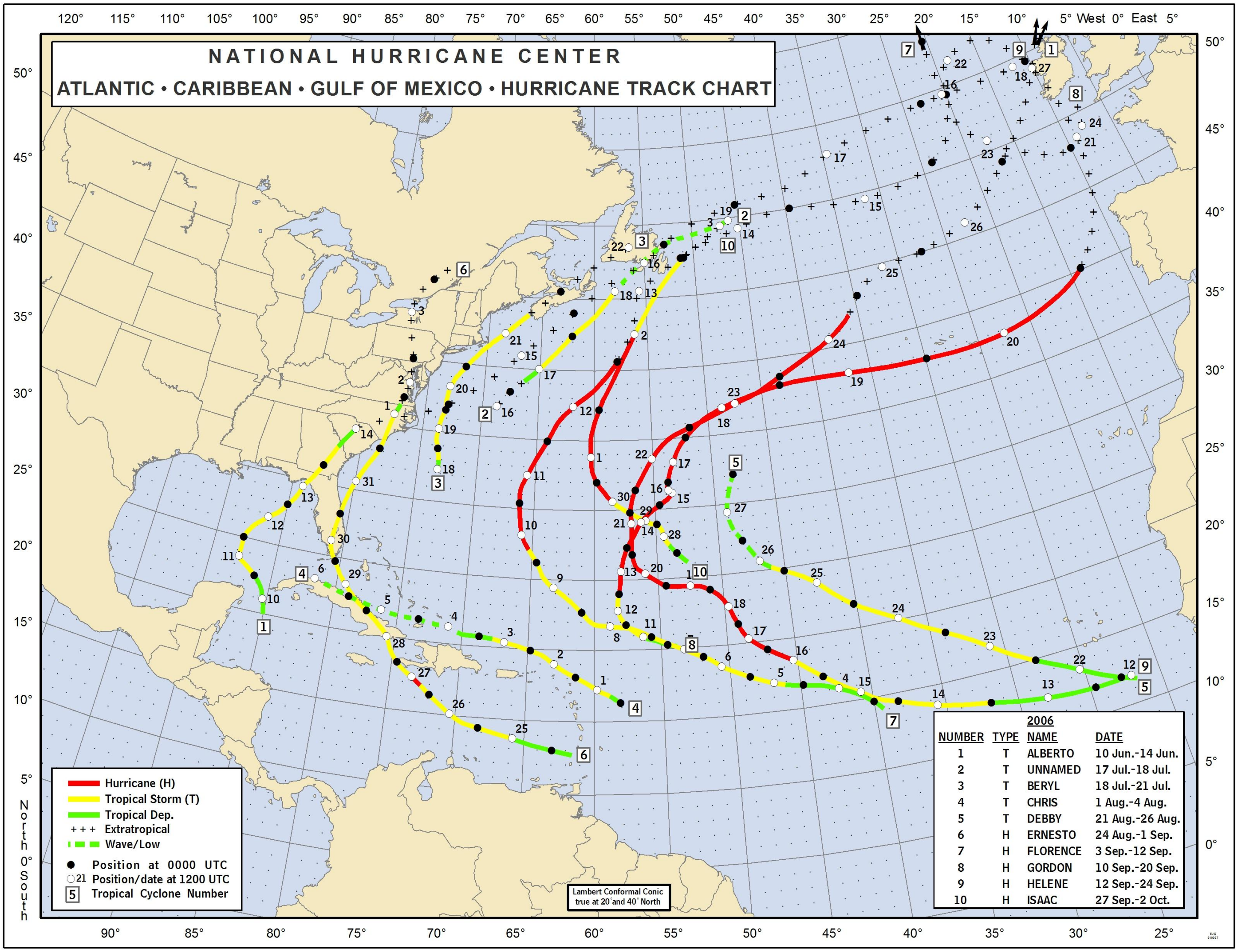
Summary Table

Name	Class[a]	Dates[b]	Maximum Winds (mph)	Minimum Pressure (mb)	Direct Deaths	U. S. Damage ($million)
Alberto	TS	Jun 10-14	70	995	0	minor[c]
Unnamed	TS	Jul 17-18	50	998	0	0
Beryl	TS	Jul 18-21	60	1000	0	0
Chris	TS	Aug 1-4	65	1001	0	0
Debby	TS	Aug 21-26	50	999	0	0
Ernesto	H	Aug 24- Sep 1	75	985	5	500
Florence	H	Sep 3-12	90	974	0	0
Gordon	H	Sep 10-20	120	955	0	0
Helene	H	Sep 12-24	120	955	0	0
Isaac	H	Sep 27- Oct 2	85	985	0	0

[a] TS - tropical storm, maximum sustained winds 39-73 mph; H - hurricane, maximum sustained winds 74 mph or higher.

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

[c] Minor damage was reported but the extent of the damage was not quantified.



Tracks of Atlantic tropical storms and hurricanes of 2006

EASTERN NORTH PACIFIC

After three below-average hurricane seasons, tropical cyclone activity in the eastern North Pacific basin was slightly above average in 2006. Eighteen tropical storms developed, and ten of these strengthened into hurricanes. Five of the hurricanes intensified into major hurricanes (category 3 or stronger on the Saffir-Simpson Hurricane Scale). These totals are above the 1971-2005 means of 15 tropical storms, nine hurricanes, and four major hurricanes. Not since the 1992 season have as many as 18 tropical storms been observed, and the last time 10 hurricanes occurred was in 1993. Moreover, the 2006 season total of 5 major hurricanes equals the highest seen since 1998. Three tropical depressions that did not strengthen into tropical storms also formed during the season. The 2006 season featured several landfalls in Mexico, following two quiet years for hurricane strikes. One major hurricane (Lane), one category 2 hurricane (John) and one tropical depression (Paul) made landfall in Mexico during the season.

Tropical Storm Aletta formed from the combination of a westward-moving tropical wave and a low-level trough near the Gulf of Tehuantepec. Early on 27 May, the system became organized into a tropical depression centered a little less than 200 miles southwest of Acapulco, Mexico. The tropical cyclone moved slowly while strengthening into a tropical storm later that day. While reaching its peak intensity of 45 mph, Aletta drifted erratically, and the storm executed a counterclockwise loop a little over 100 miles southwest of Acapulco on 28 May. The cyclone began drifting westward on 29 May while weakening to a tropical depression. Aletta continued to weaken and dissipated about 200 miles south-southeast of Manzanillo, Mexico on 30 May. Locally heavy rains occurred over portions of southern Mexico with a 24-hour total of 3.6 inches in the state of Oaxaca. There were no reports of casualties or damage.

Hurricane Bud developed from a tropical wave that reached the eastern Pacific by 7 July. A tropical depression formed from the system early on 11 July about 700 miles south of Cabo San Lucas, Mexico. Owing to a persistent high pressure area to its north, the tropical cyclone moved west-northwestward throughout its life span. Initially, some northerly vertical shear influenced the tropical cyclone, but the shear soon decreased, and the system developed rapidly and became a hurricane within about a day. Bud reached its peak strength of 125 mph (category 3) while centered about 750 miles west-southwest of Cabo San Lucas on 13 July. Thereafter, cooler waters and stable air induced rapid weakening. The cyclone dropped below hurricane strength on 14 July and weakened to a depression the next day. Bud degenerated into a remnant low pressure area on 16 July, and this remnant low dissipated in the trade winds on 17 July while located about 750 miles east-northeast of Hawaii.

Hurricane Carlotta originated from a tropical wave that entered the eastern Pacific on 9 July. An associated broad low pressure area gradually became organized into a tropical depression while centered a little less than 300 miles south of Zihuatanejo, Mexico early on 12 July. Moving briskly west-northwestward, the cyclone quickly strengthened into a tropical storm, and it became a hurricane 24 hours later. Carlotta had a large circulation initially, and its outer rainbands scraped the coast of Mexico from the Gulf of Tehuantepec to Manzanillo on 12 July. On 13 July, the forward motion began to slow while some northwesterly vertical shear, associated with the outflow of Hurricane Bud located about 700 miles to the west of Carlotta, slowed the intensification rate. Carlotta developed a banding eye and reached its peak intensity of 85 mph late on 13 July, but the northwesterly shear increased and the system weakened to a tropical storm late on 14 July. Although the northern portion of the circulation was over cooler waters, vertical shear may have decreased, and Carlotta regained hurricane strength while an eye redeveloped early on 15 July. A few hours later, however, the eye disappeared as the center passed over cooler sea surface temperatures, and Carlotta soon weakened back to a tropical storm. Decay this time was swift and uninterrupted; the cyclone weakened to a tropical depression on 16 July and degenerated to a remnant low early on 17 July. The low moved slowly westward and dissipated on 20 July about 1500 miles east of the Hawaiian Islands.

Hurricane Daniel, the strongest hurricane of the season, had a long track over the eastern and central North Pacific. It was spawned from a westward-moving tropical wave that crossed the Atlantic basin with little associated deep convection during the first couple of weeks of July. As the wave moved over the Pacific, convective organization increased, and a tropical depression formed late on 16 July centered about 525 miles south-southwest of Manzanillo. The cyclone moved westward in a light vertical shear environment to the south of a large subtropical ridge. It strengthened into a tropical storm on 17 July and into a hurricane the next day. Daniel turned west-northwestward early on 20 July, when intensification was briefly halted by an eyewall replacement cycle. Strengthening resumed after the cycle, and it is estimated that Daniel became a category 4 hurricane later on 20 July while centered a little over 1100 miles west-southwest of Cabo San Lucas. Daniel turned westward on 21 July during a second eyewall replacement cycle. After this cycle, the hurricane reached an estimated peak intensity of 150 mph early on 22 July. A slow weakening trend commenced later that day as Daniel moved over progressively cooler waters. The hurricane turned west-northwestward on 23 July, and early the next day it crossed 140ºW and entered the central North Pacific hurricane basin. As the subtropical ridge to the north weakened, the cyclone decelerated and, due to a combination of cooler waters and increasing easterly shear, Daniel weakened to a tropical storm on 25 July and to a depression the following day. It degenerated to a remnant low early on 27 July that dissipated the next day a couple hundred miles east-southeast of Hilo, Hawaii.

Tropical Storm Emilia developed from a tropical wave that produced a surface low pressure system several hundred miles south of Acapulco on 20 July. By the following day the low became organized enough to be classified as a tropical depression centered about 400 miles south-southwest of Acapulco. Convective banding features became better defined, and the cyclone strengthened into a tropical storm early on 22 July. Moving around the southwestern periphery of a large subtropical ridge, Emilia's center passed about 175 miles southwest of Manzanillo, but the storm likely produced wind gusts to tropical storm force along the southwestern coast of mainland Mexico. Emilia strengthened to its first peak intensity of 65 mph late on 23 July, but an increase in wind shear caused the storm to weaken for the next 24 hours. Emilia re-strengthened on 25 July as the shear relaxed, and the system reached a second peak intensity of 65 mph early on 26 July.

Emilia's outer rain bands affected portions of southern Baja California with locally heavy rainfall and tropical storm force winds. Elevated sites at Cabo San Lucas and Puerto Cortes reported sustained winds of 43 mph, and a gust to 55 mph was observed at the latter location. The center of the storm passed within about 60 miles of Cabo San Lazaro on the southwestern coast of the Baja peninsula on 26 July. By early on 27 July, Emilia turned toward the west-northwest over much cooler waters and began to weaken rapidly. The cyclone spun down to a tropical depression on 27 July and became a remnant low early on 28 July which dissipated three days later about 500 miles west-southwest of San Diego, California. Damage in Mexico was minor and there were no reports of casualties associated with Emilia.

Tropical Storm Fabio was a short-lived tropical cyclone that formed from a weak area of low pressure associated with a tropical wave that entered the eastern Pacific on 26 July. The associated deep convection gradually became better organized as the low passed well to the south and southwest of southern Baja California. By 31 July, the system became sufficiently well organized to designate the formation of a tropical depression centered about 975 miles southwest of Cabo San Lucas. The westward-moving system soon became a tropical storm, and it reached its peak intensity of 50 mph on 1 August. Increasing easterly vertical shear and a more stable air mass brought about weakening, and Fabio decayed to a depression early on 3 August. The cyclone degenerated into a remnant low that moved generally westward for a couple of days before dissipating several hundred miles southeast of the Hawaiian Islands on 6 August.

Tropical Storm Gilma developed from a tropical wave that moved across the tropical Atlantic and Caribbean Sea during 17-24 July with no signs of development and moved into the eastern Pacific on 25 July. The associated cloudiness, showers and thunderstorms began to show signs of increased organization on 29 July. Upper-level winds were only marginally favorable, however, and development was rather slow. By early on 1 August, the system became a tropical depression. The cyclone strengthened slightly and became a tropical storm later that day. Gilma moved west-northwestward along the southern periphery of a mid-level ridge and, despite several bursts of deep convection close to the circulation center, persistent easterly shear prevented further intensification. By early on 2 August the low-level center became completely exposed and Gilma weakened to a tropical depression. The system became a remnant low early on 4 August and the weak circulation lasted for about a day before dissipating on 5 August about 375 miles south-southwest of Cabo San Lucas.

Hurricane Hector originated from a tropical wave that reached the eastern Pacific on 10 August. Shower and thunderstorm activity gradually increased as the wave passed south of the Gulf of Tehuantepec and a broad low pressure area developed several hundred miles south of Acapulco on 13 August. The system continued to become better organized and this additional development resulted in the formation of a tropical depression late on 15 August about 750 miles south-southwest of Cabo San Lucas. While moving west-northwestward to the south of a mid-level high pressure ridge that extended from northern Mexico into the northeastern Pacific Ocean, the depression strengthened and became a tropical storm early on 16 August. Despite initially being in an environment of moderate north-northeasterly shear, Hector was able to steadily strengthen, and it attained hurricane status early on 17 August. While continuing west-northwestward, the hurricane quickly intensified, and it is estimated that Hector reached its peak intensity of 110 mph (category 2) by early on 18 August while centered about 1050 miles southwest of Cabo San Lucas. Hector remained a category 2 hurricane for about a day. Thereafter, it began to encounter cooler sea-surface temperatures and some westerly shear, which initiated weakening. The system fell below hurricane strength by 20 August. Shortly afterward, Hector approached a weakness in the subtropical ridge near 135°W longitude, which produced a considerable reduction in forward speed and a turn toward the northwest. On 21 August, deep convection became confined to the northeast portion of the circulation due to southwesterly shear. This shear was not strong enough to completely weaken the tropical cyclone and Hector remained a tropical storm with 50 mph winds for about 24 hours. The weakening cyclone turned westward in response to the low-level easterly flow. Hector decayed to a tropical depression on 23 August, and it became a remnant low shortly thereafter. This remnant circulation dissipated on 24 August about 850 miles east of the Hawaiian Islands.

Hurricane Ileana formed from a tropical wave that entered the eastern Pacific on 16 August. The system became organized slowly, and it developed into a tropical depression on 21 August a little less than 350 miles south-southwest of Acapulco. Persistent mid-level ridging over Mexico steered the system on a west-northwestward to northwestward track. After genesis, a weak-shear environment allowed for steady intensification, and Ileana became a hurricane on 22 August. The next day, Ileana strengthened into a major hurricane with 120 mph winds and its eye passed about 55 miles south of Socorro Island, causing hurricane-force wind gusts on the island. The hurricane slowly weakened on 24 August due to the effects of cooler water, but its weakening was protracted due to the continuation of a light-shear environment. Ileana diminished to a tropical storm on 26 August and weakened further to a tropical depression the next day. Ileana lost tropical cyclone characteristics late on 27 August, and drifted westward as a remnant low for a couple days before dissipating.

Hurricane John can be traced back to a tropical wave that departed western Africa on 17 August and entered the eastern Pacific one week later. Almost immediately after crossing Central America, when the system was located just to the west of Costa Rica, the associated cloud pattern began to show signs of organization. There was little or no additional development as the area of weather moved west-northwestward to the south of Central America over the next few days. On 27 August, curved bands of deep convection became better defined over the area to the south-southeast of the Gulf of Tehuantepec, and by early on 28 August the system became sufficiently well-organized to warrant its designation as a tropical depression while centered about 270 miles south of Salina Cruz, Mexico. A continued increase in organization occurred, and the cyclone became a tropical storm later that day. John moved northwestward to west-northwestward at a leisurely pace for several days to the south of a weak mid-level ridge over Mexico. On this track, the center of the cyclone moved roughly parallel to, but not far offshore of, the coast of mainland Mexico. Meanwhile, an environment of weak vertical shear and a very warm ocean promoted significant intensification. John became a hurricane by 29 August, and it strengthened into a major hurricane soon thereafter. The storm's peak intensity of 135 mph (category 4) was reached late on 30 August.

Weakening to below major hurricane status took place over the next day or so, probably in association with at least one eyewall replacement. During this time, John's eye came within about 60 miles of the coastline between Manzanillo and Lazaro Cardenas early on 31 August. On 1 September, the hurricane re-intensified to category 3 status while headed in the general direction of Baja California. Late on 1 September, the tropical cyclone turned toward the north-northwest as the mid-level ridge to the north of the hurricane weakened slightly. John's eye made landfall in extreme southern Baja California at Cabo del Este, about 45 miles northeast of Cabo San Lucas, around 0200 UTC 2 September. Although there had been some slight weakening, the hurricane's maximum winds were estimated to be near 110 mph at landfall. John moved northwestward near or just inland of the eastern coastline of the Baja peninsula, with the center of the weakening hurricane passing near La Paz. The cyclone then moved up the hilly Baja California peninsula while continuing to decrease in intensity; it became a tropical storm late on 2 September and eventually weakened to a tropical depression early on 4 September. John dissipated near the east coast of the north-central Baja California peninsula later that day.

The strongest winds observed over land were from the La Paz Observatory, where sustained winds of 52 mph with a gust to 66 mph were reported at 1000 UTC 2 September. A rainfall total of 12.5 inches was measured at Los Planes in southern Baja California, with almost 11 inches of this falling in a 24-hour period. According to press reports, John caused five deaths, all in Baja California. Two hundred homes were said to have been destroyed in the vicinity of La Paz. Over 250 homes were damaged or destroyed in the city of Mulege, located on the eastern coast of south-central Baja California. Heavy rains resulted in the overflow of the Iguagil dam in Comundu, causing 4-foot floodwaters which isolated 15 towns. Winds and rains destroyed crops over large areas and killed many livestock in southern Baja California. Although the eye of the hurricane remained offshore of mainland Mexico, John's circulation affected the coast with very heavy rains and strong winds. There were reports of a 10-foot storm surge in

Acapulco causing flooding of coastal roads in that area, but this flooding was likely due to the combined effects of surge, waves, and tides. Heavy rains produced mud slides in the Costa Chica region of Guerrero, which left around 70 communities isolated. Moisture and locally heavy rains also spread over portions of northwestern Mexico and the southwestern United States. Twenty neighborhoods in Ciudad Juarez, located across the border from El Paso, Texas, were flooded by rainfall from the remnants of John. Over three inches of rain fell in El Paso, causing some flooding and closure of roads in that area.

Hurricane Kristy originated from westward-moving tropical wave that crossed Central America on 23 August. The system remained disorganized for almost a week until shower and thunderstorm activity became more concentrated on 29 August. A tropical depression formed early the next day from this thunderstorm area about 600 miles southwest of Cabo San Lucas, and it became a tropical storm six hours later. Moving northwestward, Kristy further intensified and became a hurricane on 31 August, reaching a peak intensity of 80 mph that day. Later that same day, northeasterly shear associated with the outflow from Hurricane John increased, which caused Kristy to begin losing strength. It weakened into a tropical storm the next day. Steering currents collapsed thereafter, and the storm moved very slowly for the next few days, generally on a southward course. Vertical wind shear remained strong during this time and Kristy's intensity fluctuated between tropical storm and tropical depression strength. On 4 September, a faster westward motion resumed, and Kristy regained tropical storm status, for the last time, the next day. Its regeneration was short-lived as the storm became a tropical depression on 6 September and lost tropical characteristics on 8 September. The remnant low of Kristy moved west-southwestward for a day before degenerating into a tropical wave on 9 September.

Hurricane Lane developed from a tropical wave that entered the eastern Pacific on 10 September. The weather system slowly became better organized, and it formed into a tropical depression three days later while centered about 115 miles southwest of Acapulco. On 14 September the depression became a tropical storm and roughly paralleled the coast of Mexico while strengthening. Lane reached hurricane status the next day as it turned toward the north-northwest, its center passing about 35 miles west of Cabo Corrientes, Mexico. The system continued to intensify, and Lane had strengthened into a category 2 hurricane when its center passed just west of the Islas Marias. Later that day, Lane became a major hurricane and turned northward, reaching a peak intensity of 125 mph. A few hours later, the hurricane made landfall at that intensity in the Mexican state of Sinaloa along the Peninsula de Guevedo, about 20 miles southeast of El Dorado. Lane quickly weakened to a tropical storm early on 17 September and dissipated rapidly later that day over the high mountains of western Mexico.

A temporary tower operated by the National Oceanic and Atmospheric Administration Earth System Research Laboratory was placed at Estacion Obisbo, about 12 miles inland from the landfall location of the center. Prior to being blown down in the eyewall, the tower measured a 1-minute sustained surface wind of 93 mph with a gust to 121 mph at 1930 UTC 16 September; a sea level pressure of 966 mb was measured at the same location at 1945 UTC. A 24-hour total of 10.24 inches of rain was reported in association with Lane at San Lorenzo, Sinaloa. Media reports indicate that Lane was directly responsible for four fatalities due to floods and mud slides and that damage was heaviest in the landfall area in Sinaloa. Many streets and homes were flooded in El Dorado, Culiacan, and Mazatlan. Large rural areas were also flooded, severely impacting the agricultural industry. Numerous roads were washed out, isolating several communities, and a bridge between Culiacan and Mazatlan was destroyed. Impacts were also significant much farther south and east along the coast of Mexico, even though the center of Lane remained just offshore. Hundreds of homes were evacuated, many crops were destroyed, and some roads were damaged due to floods and mud slides in the coastal states of Michoacan, Colima, and Jalisco. The combination of high waves and heavy rains left more than a foot of water in some streets of Acapulco (and even farther southeast in the state of Guerrero), where about 200 homes were flooded and a mud slide caused one of the fatalities.

Tropical Storm Miriam formed from a large area of disturbed weather to the west of Hurricane Lane that was associated with a northward extension of the Intertropical Convergence Zone. The disturbed weather area gradually became organized, and a tropical depression formed early on 16 September, about 500 miles southwest of Cabo San Lucas. The depression moved northeastward and became a storm later that day, reaching its peak intensity of 45 mph early on 17 September. Thereafter, northeasterly wind shear and inflow of cool stable air began to affect the storm. The short-lived system weakened to a depression that degenerated to a remnant low by late on 18 September. The remnants of Miriam moved generally northward before dissipating on 21 September just offshore of southern Baja California.

Tropical Storm Norman originated from a tropical wave that moved into the eastern Pacific on 1 October. The wave moved westward for about a week, first showing signs of organization on 8 October. A tropical depression formed from the wave the next day about 765 miles southwest of Cabo San Lucas. The depression became a tropical storm 12 hours later as it moved north-northwestward. Norman attained a peak intensity of 50 mph early on 10 October, but then increasing southwesterly shear caused a rapid weakening of Norman to a tropical depression later that day. The cyclone turned to the east-northeast and degenerated into a remnant low on 11 October about 530 miles southwest of Cabo San Lucas. The remnants of Norman moved generally east-southeastward for the next few days due to its interaction with a large cyclonic circulation near the coast of southwestern Mexico. Norman redeveloped into a short-lived tropical depression on 15 October about 200 miles south-southwest of Manzanillo that dissipated by the end of the day offshore of Mexico. Although the center remained offshore, Norman produced localized heavy rains in portions of southwestern Mexico. No casualties or damage have been attributed to the storm.

Tropical Storm Olivia was spawned from a tropical wave that moved into the eastern Pacific on 29 September. The system took a rather long time to develop, initially forming into a surface low on 5 October. However, only sporadic thunderstorm activity occurred with the low for the next few days, until the system became better organized on 9 October. Later that day, a tropical depression formed about 1350 miles west-southwest of Cabo San Lucas. The depression turned northward and became a tropical storm early on 10 October, reaching a peak intensity of 45 mph later that day. Southwesterly shear caused a rapid weakening of the cyclone, diminishing it to a tropical depression on 11 October. Olivia turned eastward and slowly lost tropical cyclone characteristics, becoming a remnant low on 13 October. The remnants of this system were absorbed by a large area of disturbed weather near the southwestern coast of Mexico that was partially associated with the remnants of Norman.

Hurricane Paul formed from a tropical wave that crossed Central America on 18 October and moved into an area of disturbed weather over the eastern Pacific the next day. A couple of days later, a low pressure system developed in this area, and a tropical depression formed early on 21 October about 265 miles south-southwest of Manzanillo. Moving westward, the depression became a tropical storm later that day, but further development was impeded by easterly shear. However, by late on 22 October the shear had decreased and Paul began to intensify rapidly. Paul became a hurricane on 23 October and reached a peak intensity of 105 mph later that day. A large trough off the west coast of the United States turned Paul to the north on 23 October. This trough also produced an increase in wind shear, which caused the tropical cyclone to begin weakening. Paul accelerated northeastward the next day as it diminished to a tropical storm. The center of the cyclone passed just south of Cabo San Lucas as a minimal tropical storm early on 25 October; Paul weakened to a depression later that day. The depression abruptly turned northward with a decrease in forward speed as it approached the coast of southwestern Mexico, then moved inland and dissipated early on 26 October near the southern end of Isla Altamura, about 55 miles northwest of Culiacán. High surf from Paul caused two deaths in southern Baja California. Paul also caused significant flooding in Sinaloa, resulting in two deaths in that state.

Tropical Storm Rosa was generated from a tropical wave that entered the eastern Pacific on 3 November. A couple of days later, a broad low pressure area developed from this wave several hundred miles south of the Gulf of Tehuantepec. Convection associated with the low was disorganized initially but increased near the center late on 7 November, leading to the formation of a tropical depression early on 8 November about 450 miles south of Manzanillo. The system moved slowly northwestward during its entire lifetime. The cyclone was in an environment of strong southwesterly shear, and Rosa was only briefly a tropical storm on 9 November before it weakened back to a tropical depression the next day. The circulation degenerated into a trough of low pressure later on 10 October about 250 miles southwest of Manzanillo.

Hurricane Sergio appears to have been spawned by a tropical wave that crossed southern Central America and entered the eastern Pacific on 7 November. An area of cloudiness and showers associated with the wave moved slowly westward to the south of Central America and eastern Mexico over the next several days. Showers and thunderstorms became more concentrated by 12 November over an area centered roughly 400 miles south of Acapulco. By late on 13 November, when the system was centered about 475 miles to the south of Manzanillo, it had acquired enough surface circulation and organized deep convection to be designated a tropical depression. Initially the cyclone was moving northwestward, but it soon stalled while strengthening into a tropical storm on 14 November. Sergio then turned toward the southeast, apparently due to the flow associated with a mid- to upper-level trough to its northeast, and continued to intensify. While situated in an environment of light vertical shear, with anticyclonic flow aloft and a generally moist troposphere, the storm became a hurricane on 15 November, and it quickly strengthened to a peak intensity of 110 mph later that day. Sergio exhibited a distinct and very small eye around that time. The hurricane then turned toward the northeast and north-northeast and weakened as westerly shear, associated with an upper-level trough, increased over the tropical cyclone. By early on 17 November, the low-cloud circulation became partially exposed on the west side of the deep convection, and it is estimated that Sergio weakened to a tropical storm. During the next few days, an area of high pressure built to the northeast and north of the tropical cyclone, which forced the system to turn toward the northwest, west, and eventually west-southwest. Although there was some slight restrengthening on 18 June when deep convection reformed near the center, Sergio was mainly on a weakening trend as persistently strong shear took its toll. The cyclone weakened to a tropical depression early on 20 November, and it dissipated later that day about 350 miles southwest of Manzanillo, as the low-level circulation became indistinct.

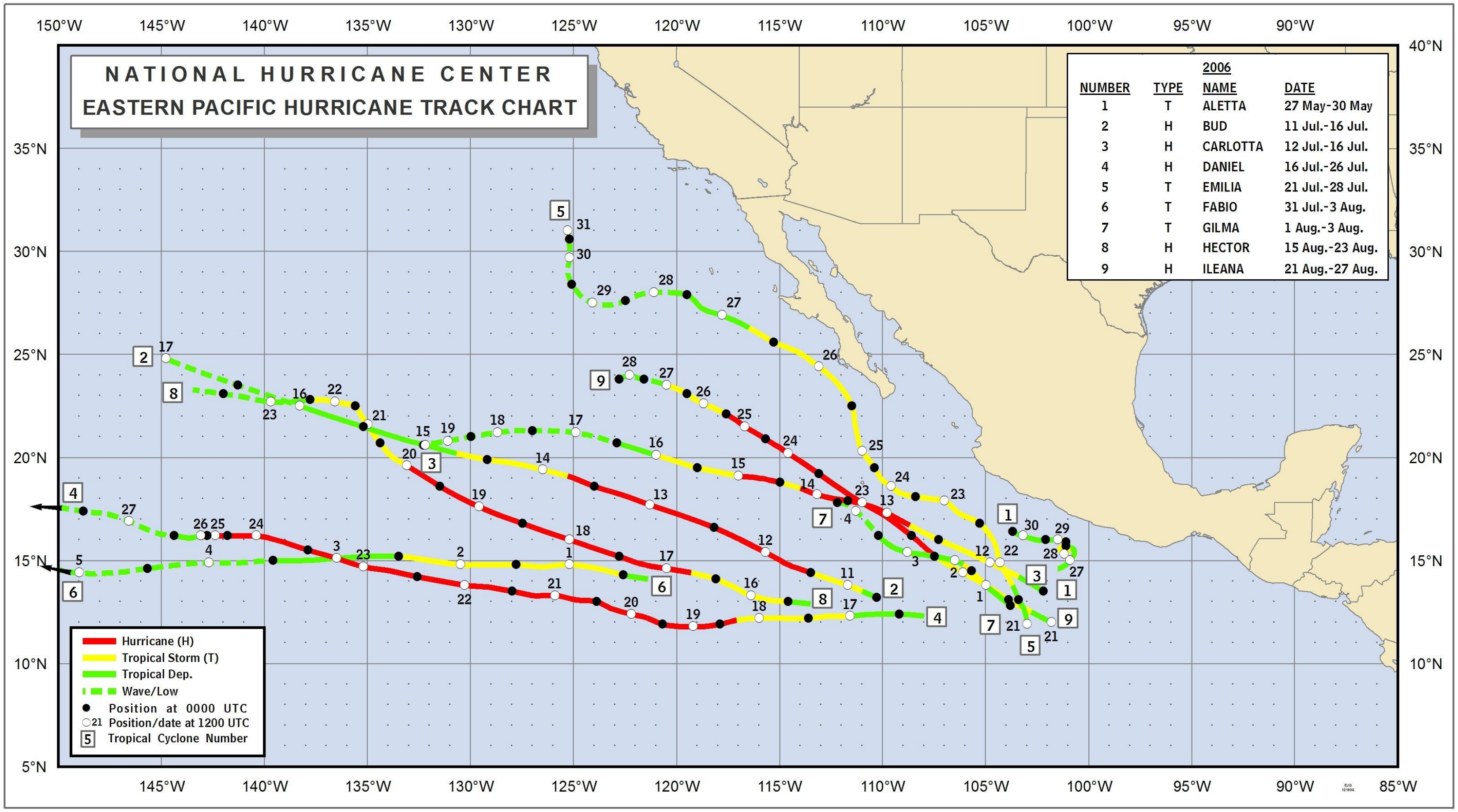
2006 eastern North Pacific Tropical Storms and Hurricanes

Name	Class[a]	Dates[b]	Winds (mph)	Pressure (mb)	Deaths
Aletta	TS	May 27-30	45	1002	
Bud	H	July 11-16	125	953	
Carlotta	H	July 12-16	85	981	
Daniel	H	July 16-26	150	933	
Emilia	TS	July 21-28	65	990	
Fabio	TS	July 31-August 3	50	1000	
Gilma	TS	August 1-3	40	1004	
Hector	H	August 15-23	110	966	
Ileana	H	August 21-27	120	955	
John	H	August 28-September 4	135	948	5
Kristy	H	August 30-September 8	80	985	
Lane	H	September 13-17	125	952	4
Miriam	TS	September 16-18	45	999	
Norman	TS	October 9-15	50	1000	
Olivia	TS	October 9-12	45	1000	
Paul	H	October 21-26	105	970	4
Rosa	TS	November 8-10	40	1002	
Sergio	H	November 13-20	110	965	

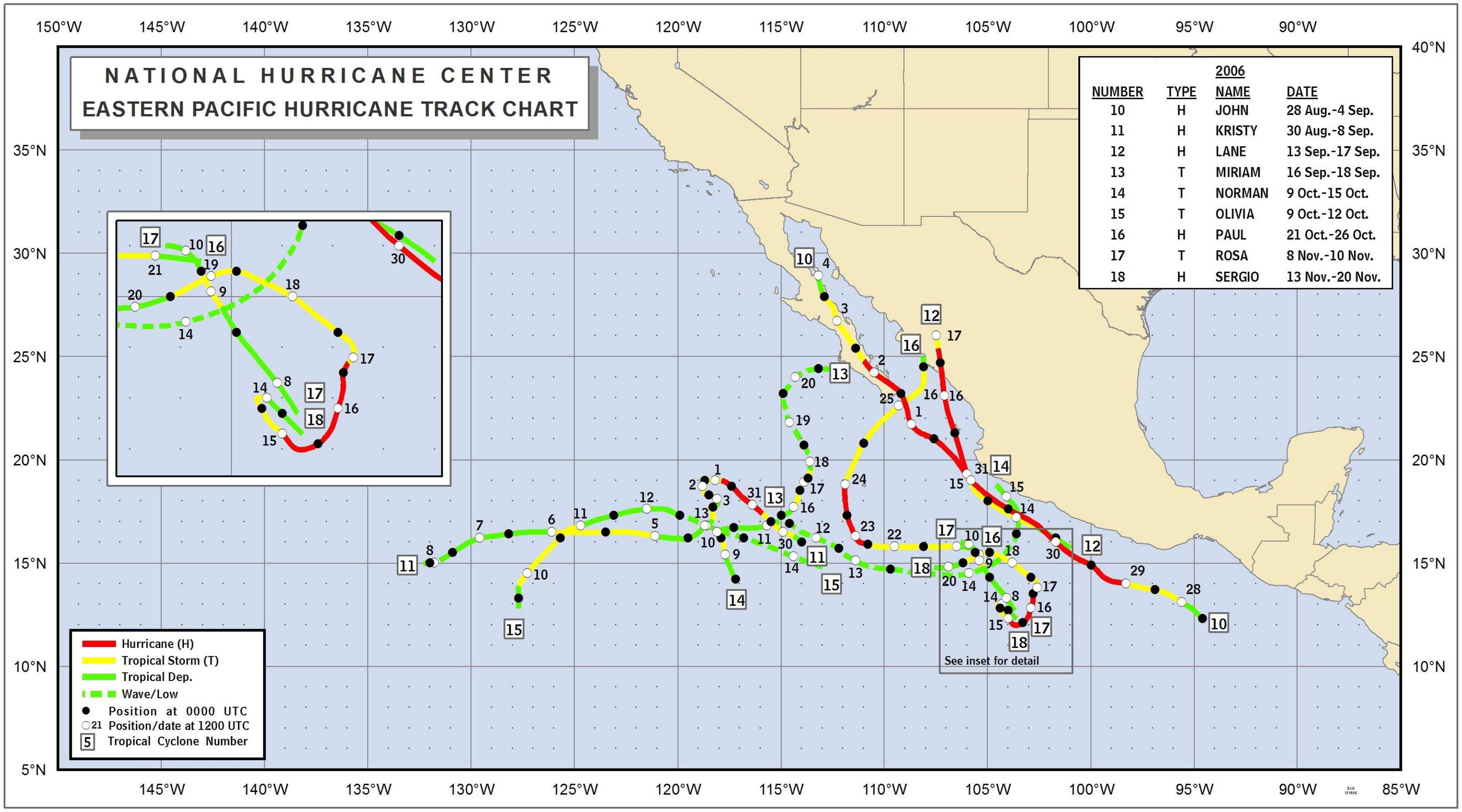
[a] TS - tropical storm, maximum sustained winds 39-73 mph; H - hurricane, maximum sustained winds 74 mph or higher.

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

APPENDIX III



Tracks of eastern North Pacific tropical storms and hurricanes of 2006: Aletta through Ileana



Tracks of eastern North Pacific tropical storms and hurricanes of 2006: John through Sergio

APPENDIX IV

REVIEW OF THE PAST HURRICANE SEASON

Reports of hurricanes, tropical storms, tropical disturbances and related flooding during 2006

(Submitted by Members of the RA IV Hurricane Committee)

ANTIGUA AND BARBUDA

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

The year 2006 was fairly benign generating nine (9) storms of which five (5) developed into hurricane and of those five hurricanes, two (2) developed further into intense hurricanes.

Antigua and Barbuda and the Leeward Islands were once again fortunate not to be affected by any Tropical Storms or Hurricanes during 2006.

It should be noted that a Tropical Storm warning was issued for Antigua and Barbuda and portions of the Leeward Islands on August 1st and 2nd due to the proximity of Tropical Storm Chris, however this weak system did not affect the islands.

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

BARBADOS

The Atlantic hurricane season of 2006 represents a mild and uneventful experience for Barbados. After the record-breaking activity of 2005, this year must be regarded as one of below-normal tropical cyclone activity. By the end of the year ten (10) named storms had formed, five of which reached hurricane intensity and of these, two were classified as major hurricanes. The period from October to November was non-productive and little interest was generated as the season, influenced by a developing El Nino, came to a standstill.

The season peaked in September when four hurricanes developed and slightly above normal tropical cyclone activity was experienced. None of these systems posed a threat to Barbados.

On August 24, a developing depression generated inclement weather in Barbados and some of the neighbouring islands. The system produced rainfall amounts of 90.0 mm or more in some parts of the island, and wind gusts in excess of storm force across the island. The depression was upgraded to tropical storm Ernesto the following morning, while emerging over the southeast Caribbean Sea.

During the month of October, the weather was generally unstable, and some significant rainfall events were recorded. These unsettled conditions continued into the month November, and a number of tropical downpours were recorded across the island. Some of these resulted in localized flooding in parts of the island. The rapid accumulation of run-off from the heavy showers produced flash flooding in Bridgetown and suburban areas. In some cases the run-off overwhelmed the drainage system, and inundation quickly resulted.

Despite the periodic moderate to heavy downpours, rainfall totals for the first eleven months of the year remain below the historical average. The significant shortfall, which was experienced during the period, March to July, is yet to be made up.

Another feature of the year's weather was the persistent high temperature regime of 32.0 degrees Celsius or more. During the peak of the wet season, August to October, these extreme temperatures were recorded on fifty-one days, with the pattern persisting for six consecutive days on two occasions.

Naturally, this local experience has continued to fuel the debate over and given credence to the "global warming" perception. Although no deaths were directly attributable to the persistent elevated temperatures, significant amounts of time, energy and resources were expended in creating a cooler and more comfortable environment for people affected by the heatwave.

CANADA

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45 Alderney Drive
Dartmouth, Nova Scotia B2Y 2N6 CANADA
Website: http://www.hurricanes.ca

2006 TROPICAL CYCLONE SEASON SUMMARY

Six tropical cyclones or their remnants entered the Canadian Hurricane Centre (CHC) Response Zone (RZ) in 2006. Of these storms, three remained offshore over Canadian waters (Florence as a hurricane, Isaac as a tropical storm, and an unnamed tropical storm), and three moved inland in their post-tropical stage (Alberto, Beryl, and Ernesto). Florence was the most destructive tropical cyclone of the season for eastern Canada. No Canadian fatalities were attributed to any tropical cyclone in 2006. Tropical storm warnings were issued for Nova Scotia for T.S. Beryl and for Newfoundland for Hurricane Florence and T.S. Isaac. The CHC issued a total of 93 information statements.

BULLETIN SUMMARIES	2006	2005	2004	2003	2002	2001	2000	1999
Hurricane Information Statements (WOCN3X/7X CWHX)	93	87	104	113	68	110	109	71
Number of Storms Represented by these Bulletins	5	7	8	8	8	6	8	6

Alberto (June 10–16)

Tropical Storm Alberto weakened June 13-14 as it went through the Carolinas but then underwent rapid extratropical transition (ET) while entering the RZ well east of Maryland late on the 14th. Alberto deepened into a powerful post-tropical storm as it passed south of Nova Scotia late on the 15th and then through Newfoundland on the 16th. Maximum sustained / peak marine winds observed by a Canadian NOMAD weather buoy on the afternoon of the 15th were 46 knots (85 km/h) / 60 knots (111 km/h), respectively. The maximum sustained / peak winds over land were from Nova Scotia on the 15th where 45 knots (83 km/h) / 64 knots (119 km/h) were reported. There were some trees damaged and local power outages in Nova Scotia. The Atlantic Storm Prediction Centre (ASPC) issued marine storm and gale warnings. The CHC issued 15 information statements.

Unnamed Storm (July 17–18)

A tropical cyclone formed in the southwest quadrant of the RZ overnight on July 16th after a weak extratropical low moved over warm water, developed deep convection, and became a tropical depression. The cyclone strengthened into a tropical storm as it entered Canadian waters early on the 17th with maximum sustained / peak wind reports from the buoy network of 31 knots (56 km/h) / 38 knots (70 km/h) respectively, on the 18th, although by this time the storm was already losing tropical characteristics. The storm weakened below gale strength before passing through Newfoundland late on the 18th. No significant impacts were reported. The ASPC issued marine gale warnings. The CHC coordinated messaging with the ASPC but did not issue any bulletins.

Beryl (July 18–July 23)

Tropical Storm Beryl entered the RZ late on July 19th, entered southwestern Canadian waters on the morning of the 21st as it underwent ET, and made landfall in southwestern Nova Scotia as a post-tropical storm in the afternoon of the 21st. Peak winds in excess of 43 knots (80 km/h) were reported around Nova Scotia on the 21st, with the maximum being 52 knots (96 km/h). Rainfall amounts in Nova Scotia were generally 25-50 mm (1-2 in.). The maximum official rainfall was 71 mm (2.8 in.) with an unofficial total of 88 mm (3.5 in.). Heaviest rain rates were 25 mm (1 in.) in one hour. Impacts included localized stream overflows onto roadways, and broken tree limbs resulting in local power outages in the capital city of Halifax,. The ASPC issued marine gale warnings and inland rain warnings. The CHC issued tropical storm warnings for Nova Scotia and 23 information statements.

Florence (September 3–14)

Hurricane Florence entered the RZ just after midnight on the morning of September 12th. It was a large hurricane that was undergoing ET and completed transition prior to entering southeastern Canadian waters on the evening of the 12th. Post-tropical Florence intensified slightly and maintained hurricane force winds as it passed within 10-20 n.miles (19-37 km) of southeastern Newfoundland. Peak wind gusts reported from Newfoundland on September 13th include 88 knots (163 km/h) at Sagona Island, 72 knots (133 km/h) at St. Lawrence, and 69 knots (128 km/h) at St. Pierre (not known for reporting high winds). Peak marine winds of 67 knots (124 km/h) were reported by a buoy in southeastern Maritime waters while the highest waves were reported by buoys in the Grand Banks (9.8 m significant waves and 18.7 m maximum waves). Southeastern Newfoundland received 30-50 mm (1.2-2.0 in.) of rain with a maximum official report of 58.8 mm (2.3 in.) and an unofficial report of 67 mm (2.6 in.). Impacts include a house that was destroyed in the community of Francois, road washouts from coastal waves, power blackouts in portions of southeastern Newfoundland, a couple of grounded boats, fallen trees and some damaged roofs. The ASPC issued marine storm and gale warnings and inland wind and rain warnings. The CHC issued tropical storm warnings for Newfoundland and 27 information statements.

Isaac (September 27–October 3)

Isaac entered the CHC RZ on the evening of Oct 1st as a hurricane but weakened to a tropical storm as it entered southeastern Canadian waters on the morning of the 2nd. Isaac remained tropical as it passed within 45 km of Cape Race Newfoundland late in the afternoon of the 2nd, following which it underwent rapid ET. On October 2nd maximum sustained / peak winds reported over Newfoundland were 40 knots (74 km/h) / 52 knots (96 km/h) while an offshore buoy reported maximum sustained / peak winds of 44 knots (82 km/h) / 56 knots (104 km/h). The rapidly moving storm only generated a maximum of 26 mm (1 in.) of rain over extreme southeastern Newfoundland. No significant impacts were reported. The ASPC issued marine gale warnings. The CHC issued tropical storm warnings for Newfoundland and 21 information statements.

Additional Information

1. Tropical Storm Ernesto . . . moved into North Carolina on September 1st and tracked up through southeastern Ontario on September 3rd as a weak dissipating extratropical cyclone. Maximum rainfall in Ontario was 54 mm (2.1 in.). The CHC coordinated messaging with the Ontario Storm Prediction Centre but did not issue any bulletins.

2. Hurricane Helene . . . remained outside of the RZ with no impacts on Canada, although the CHC did issue 7 pre-emptive bulletins on September 20-21.

3. In late October an extratropical cyclone persisted in the northern Pacific. The storm drifted over anomalously warm water and developed central convection, eventually developing a clear eye and eyewall. The system dissipated in early November, but not before bringing very heavy rains to portions of Vancouver Island. It was never officially declared to be a tropical cyclone.

COLOMBIA

During the 2006 Atlantic, Caribbean and Gulf of Mexico hurricane season, there were no cyclonic systems in the Colombian part of the Caribbean Sea that directly or indirectly affected the country.

CUBA

The 2006 Hurricane Season was about normal regarding the amount of tropical storms and hurricanes formed over the open Atlantic areas. Notwithstanding, it was of very poor activity in the Caribbean and Guff of Mexico basins. The main inhibiting factor was the ENSO event (El Niño/Southern Oscillation) which caused subsidence and also increased vertical shear in the Caribbean area. Another possible limiting factor was the frequent intrusion of dry air over the tropical Atlantic flowing from the Saharian region in the months of July, and mainly in August.

This Hurricane Season was rather beneficial to Cuba, for the country was suffering an intense drought for several months, while “Alberto” and “Ernesto” caused rain accumulations between

100 y 400 mm. The dams gathered water up to 94% of their nominal capacity, practically ending the drought conditions in the country.

ALBERTO (10 - 14 junio)

"Alberto" was the first tropical depresión of the 2006 season. It formed in a low pressure area during the early morning hours of June 10th, 210 kilometres South of Cape San Antonio, Pinar del Rio, Cuba. This tropical depression was located under the influence of Westerly shear and showed an exposed center of circulation, with deep convection mainly over Western Cuba and adyacent waters. A maximum wind gust of 105 km/h was recorded at 3:00 AM (07:00 UTC) at Punta del Este meteorological station in the Isle of Youth, Cuba.

The depression headed toward the NNW, crossing the Yucatán Channel 70 km away of Cape San Antonio, Western tip of Cuba.

Convective bands associated with "Alberto" caused numerous and intense rains in the Havana provinces, Isle of Youth and the province of Pinar del Rio as well, on June 10th and 11th. Although these rain bands continued over Western Cuba on the 12th the most significant rain totals were recorded on the 11th, mainly in Pinar del Rio. The highest 24-hour value was recorded in Rio Seco: 445 mm. The rest of the Western provinces had rain accumulations in 24 hours between 100 and 400 mm. These rains were of great benefit due to the intense drought conditions suffered by this area prior to "Alberto".

Cuba had neither fatalities nor damages associated to Alberto.

ERNESTO (August 24 - September 1st)

Ernesto was the sixth tropical depression formed on this season. It originated in a tropical wave on the Eastern Caribbean near the Granadines, Lesser Antilles, on August 24th. The depression headed between West and Westnorthwest at 25 km/h. It reached tropical store strength on August 25th. It was upgraded to a hurricane on the 27th, with 120 km/h winds and a minimal pressure of 992 hPa. The interaction with the mountains of Hispaniola weakened the circulation to a tropical storm on the morning of the 27th.

The storm center entered Cuban territory on August 28th at 8:00 AM (12:00 UTC) by the province of Santiago de Cuba, near Cazonal Beach. Maximum sustained winds were 65 km/h with a minimal pressure of 1005 hPa.

The poorly defined center crossed the province during the morning hours. At noon and early afternoon, it crossed the province of Holguin, and it was already over the province of Las Tunas in late afternoon. It entered the Northeastern Camaguey province and continued over Northern Camaguey that evening and was over the province of Ciego de Avila at midnight, exiting the keys to the North of that province and into open seas around 5:00 AM (09:00 UTC), by a point near the provincial border between Ciego de Ávila and Villa Clara.

The track of Eduardo over Cuba, at a mean speed of 22 km/h, produced numerous and intense rains in Eastern Cuba, of most benefit to this region, hardly hit by a severe drought, mainly in Santiago de Cuba, Guantanamo and Las Tunas. Rain amounts in 24 hours reached between 100 and 300 mm.

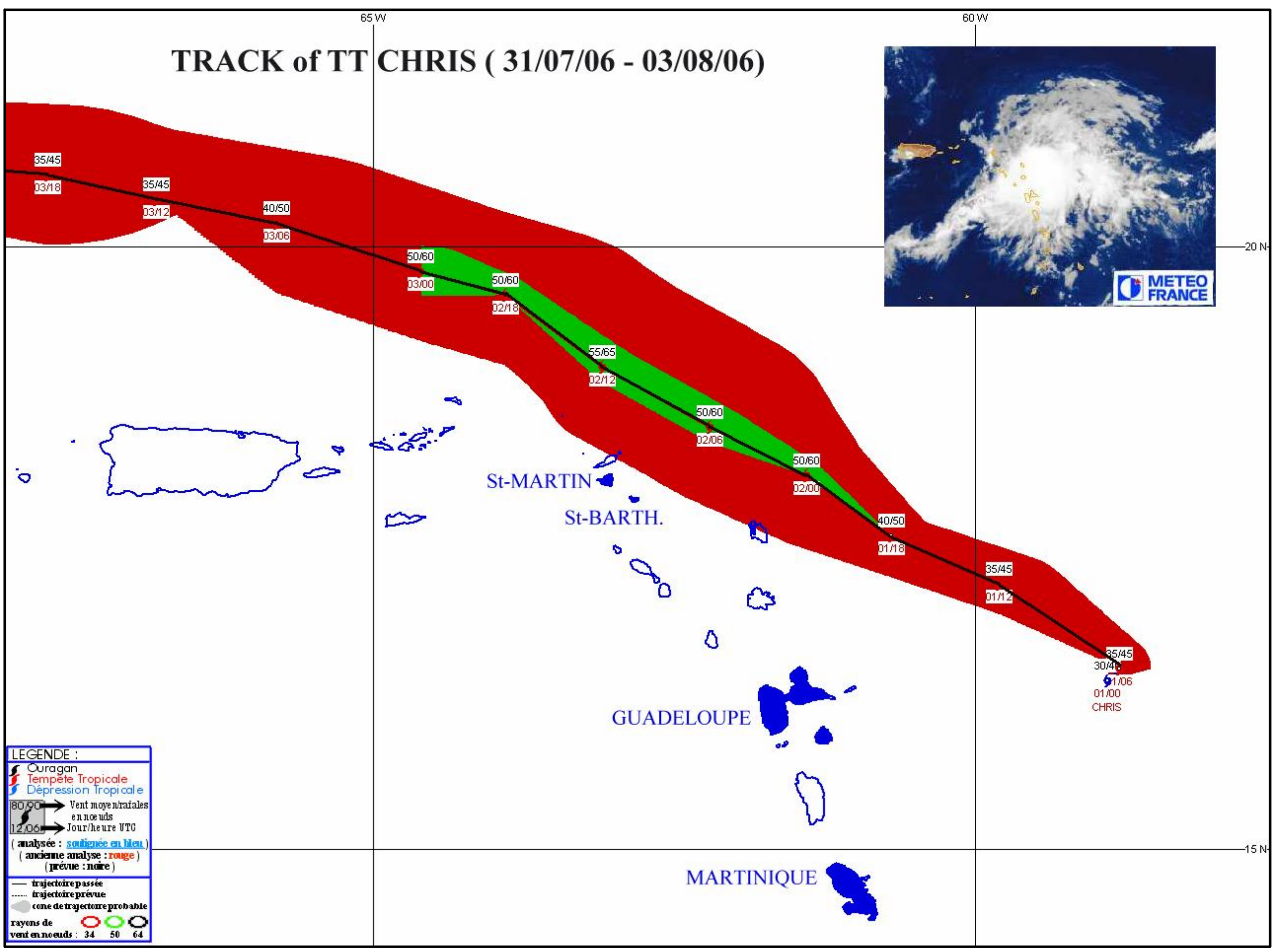
FRANCE

DIRECTION INTEREGIONALE ANTILLES GUYANE

SUMMARY OF THE 2006 HURRICANE SEASON IN THE FRENCH WEST INDIES
(Martinique, Guadeloupe St Barthelemy and St Martin)

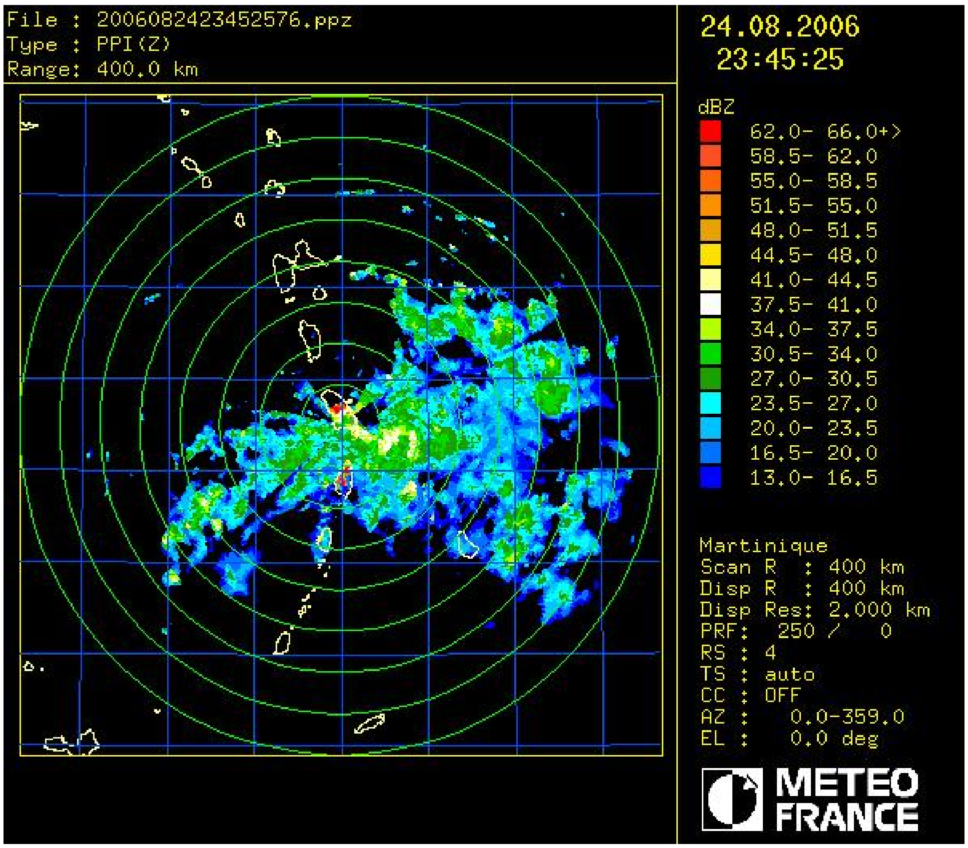
During this "unexpected" poor hurricane season, the FWI only had to deal with two cyclones that did not produce any damage for the islands.

- ***Chris*** has been the only threat for the northern islands. The forecast of the 31/07 at 11 pm lead to a "vigilance jaune cyclone" (DT/TT watch) at midnight for St Barth and Saint-Martin. Then, in the morning of 1 August, with the birth of Chris, the level has has been upgraded to "orange" (TT warning). Finally, the center of TT Chris passed 80-90km north of the islands on 2 August and none of the islands were concerned with tropical storm winds (only with some rainfalls). The "vigilance orange cyclone" was cancelled on 02/08 at 11 am.

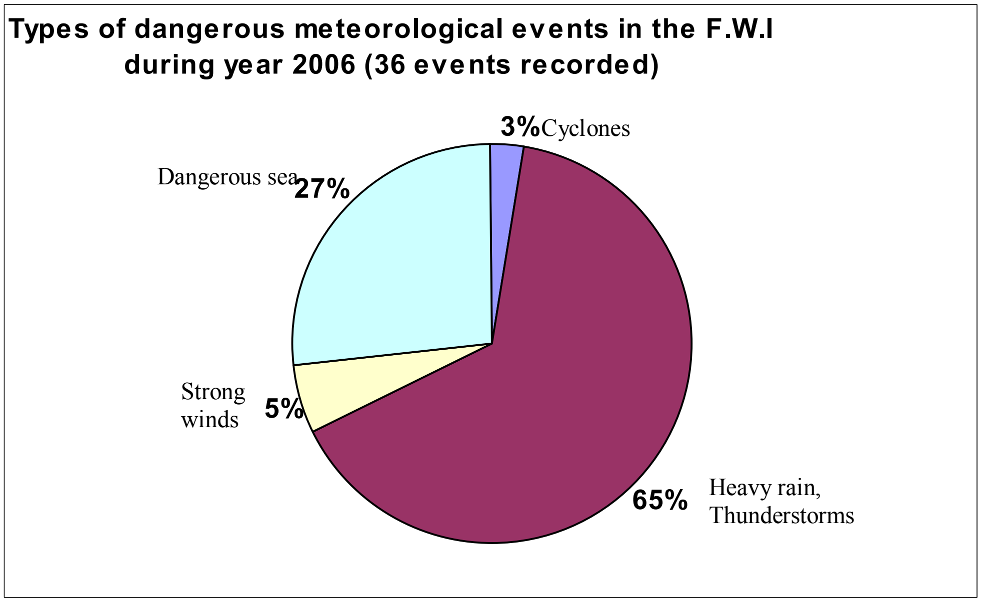


- Martinique has been concerned with rainfalls and gusts associated with DT5 (future TT Ernesto) on the 24/08, as the centre of the depression was just few kilometres off the west side of the Grenadines. A yellow level for heavy rain and thunderstorm was decided from the 24/08 at noon to the 25/08 at 6am local time.

The normally dry south part of the our island experienced 4 inches of rain (100mm) during this period and gusts between 70 and 90 km/h were recorded.



To summarize, here is an overview of all the dangerous events that the FWI experienced this year.



JAMAICA

The 2006 hurricane season was near normal with ten tropical storms, five of which became hurricanes, two of which becoming major hurricanes. Jamaica was threatened once during the 2006 hurricane season.

Hurricane Ernesto developed from a tropical wave that moved off the coast of Africa on August 18. On the 23rd August as the wave approached the lesser Antilles, convection began to increase and on the 24th developed a closed circulation – Tropical depression # 5 approximately 250 km South West of Martinique over the South Eastern Caribbean Sea.

Bulletin # 1 was issued by the meteorological service on August 25 at 11.00 am with Tropical Depression # 5 near 1,220 km east-south-east of Morant Point Jamaica and Ernesto forecasted to become a strong tropical storm passing south of Jamaica Sunday morning August 27.

A tropical storm watch was issued by the meteorological Service in Bulletin # 2 at 4.00 pm on August 25 as tropical storm Ernesto developed near 1,000 km east-south-east of Morant Point. The forecast track was adjusted to have Ernesto passing directly across Jamaica by late Sunday morning. Evacuation orders were issued for fishers on the cays and banks.

At 10.00 am on August 26 a Hurricane Watch was issued for Jamaica while the tropical Storm watch was upgraded to Tropical Storm Warning with Ernesto strengthening about 620 km east-south-east of Morant Point.

The Forecast Track was again adjusted taking Tropical Storm Ernesto between Jamaica and the South East coast of Cuba by which time Ernesto could strengthen to near hurricane strength.

On August 27 at 5.00 am, Ernesto slowed and rapidly strengthen to hurricane status while some 340 km east-south-east of Morant Point, but luckily for Jamaica began a turn towards the North West.

By 5.00 pm on August 27 Ernesto weakened to Tropical Storm status and the Hurricane Watch was discontinued by Jamaica in Bulletin # at 11.00 pm that night and the Tropical Storm Watch discontinued at 5.00 am the following morning.

Spiral bands from Ernesto brought heavy rains to Jamaica and flashflood watches and warning were issued for low-lying and flood prone areas of Central and Eastern Parishes.

Meanwhile heavy rainfall across the island 22-23 November 2006 resulted in significant flooding in the North Eastern Parishes of Jamaica (Portland and St. Mary). This was due to the passage of a cold front, which became stationary just east of the island.

Strong Northerly winds and lower than normal temperatures were also experienced.

Sections of Portland and St. Mary received in excess of 100 % of the long term mean rainfall for the month over the two-day period with some stations receiving in excess of 400 mm in the two days. There was one death from landslide.

MEXICO

The 2006 tropical cyclone season in Mexico can be characterized as close to the historical average. Four tropical systems affected the coastline directly, all of them of Pacific origin, none from the Atlantic. The average number directly affecting Mexico from both oceans during the period 1970-2005 is 4.24 cyclones per annum.

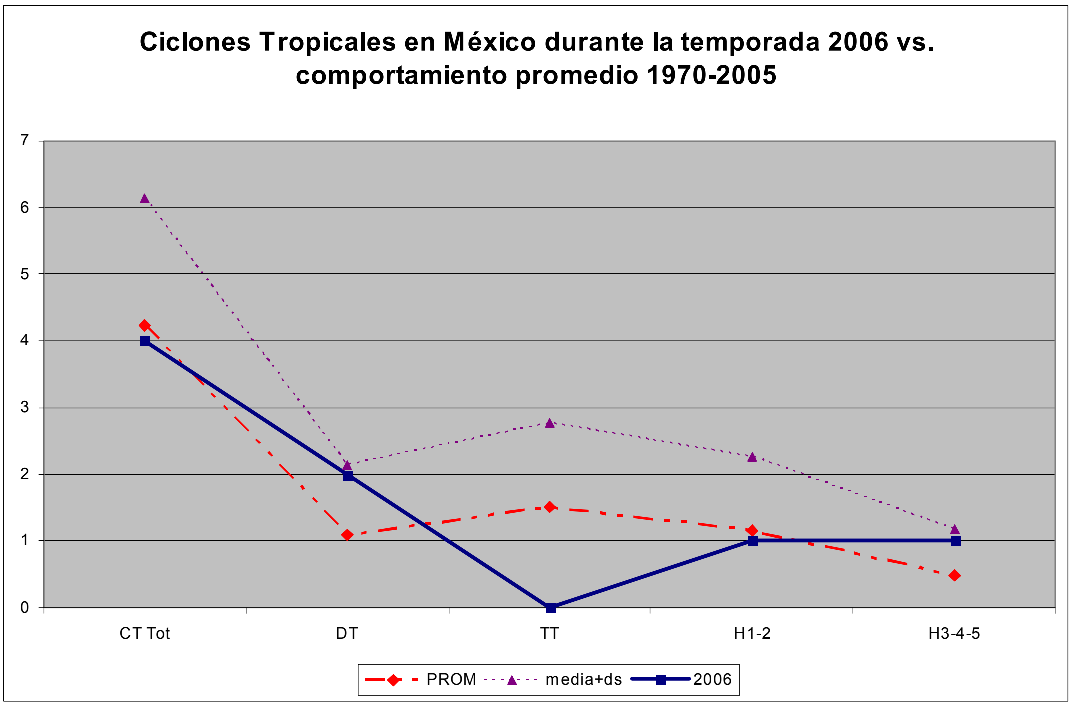


Figure 1 – Comparison of the 2006 cyclone season in Mexico with the average for 1970-2005

During the 2006 season, four cyclones directly affected the Mexican coasts: hurricanes *John* and *Lane* and tropical depressions *Norman* and *Paul*.

Hurricane *John* lasted from 28 August to 4 September then, after reaching maximum sustained winds of 215 km/h, it made landfall on 1 September at 9.00 p.m. local time at El Saucito, BCS, with maximum sustained winds of 175 km/h and gusts of 210 km/h, as a category 2 hurricane on the Saffir-Simpson Scale. *John* affected the state of Lower California South with a maximum 24-hour rainfall total of 449 mm in the San Bartola station.

Hurricane *Lane* lasted from 13 to 17 September and also affected the Mexican coast, reaching maximum sustained winds of 205 km/h with gusts of 250 km/h and being classified as a category 3 hurricane on the Saffir-Simpson Scale. It made landfall at this force between Cruz de Elota and Laguna de Canachi, Sinaloa, on 16 September at about 1 p.m. local time. The maximum amount of rainfall brought by *Lane* was 260.5 mm in San Lorenzo, Sinaloa.

Norman developed from 8 to 15 October, starting far away from the Mexican coast then, after reaching wind speeds of 85 km/h with 105 km/h gusts, on the afternoon of 15 October, already a tropical depresión with maximum sustained winds of 55 km/h, it came to a point WNW of the coastline of Manzanillo, Col., where the frontal part of the system had a direct impact. Its circulation caused intense rainfall in Michoacán, Colima and Jalisco, with a maximum 24-hour total of 161 mm at La Villita reservoir, Mich.

Paul, lasting from 21 to 26 October, after reaching category 2 hurricane force on the Saffir-Simpson Scale, with maximum sustained winds of 175 km/h and 215 km/h gusts, made landfall on 25 October at 10 p.m. local time, close to the town Lucenilla, Sin., as a tropical depresión with maximum sustained winds of 45 km/h. The maximum 24-hour rainfall total was 74.5 mm in San Juan, Sinaloa.

Operation of the warning system at the National Meteorological Service of Mexico

The National Meteorological Service (NMS) kept a 24/7 tropical cyclone watch throughout the 2006 season. A total of 419 tropical cyclone warnings were issued for the Pacific and 92 for the Atlantic.

RECAPITULATION OF TROPICAL CYCLONES IN MEXICO DURING THE 2006 SEASON

Tropical cyclone	**Track** (km)	**Duration** (h)	**Warn-ings**	**Landfall in Mexico**		**Maximum 24-hour rainfall total** (mm)	**Human and material losses (*)**
				Place	**Maximum winds**		**Deaths**
H2 *John*	2,765	168	64	El Saucito, Lower California South	175 km/h	449.0 mm, San Bartolo, BCS.	6
H3 *Lane*	1,450	90	32	Cruz de Elota, Sinaloa	205 km/h	260.5 mm, San Lorenzo, Sinaloa	4
TD *Norman*	1,905	65	14	40 km al W-NW de Manzanillo, Colima	55 km/h	161.0 mm, Presa La Villita, Michoacán	0
TD *Paul*	1,930	120	32	Punta Lucenilla, Sinaloa	45 km/h	74.5 mm, San Juan, Sinaloa	0

* Provisional figures supplied by Coordinación General de Protección Civil, Secretaría de Gobernación

Notable hydrometeorological phenomena in Mexico in 2006

In 2006, Mexico was affected by the passage of four 4 tropical cyclones, 59 cold fronts, 47 tropical waves and 6 winter storms (cold lows). The NMS recorded a total of 517 severe storms (threshold > 70 mm/24 h), the maximum total rainfall being 449 mm in San Bartolo, Lower California South, on 1-2 September, caused by Hurricane *John*.

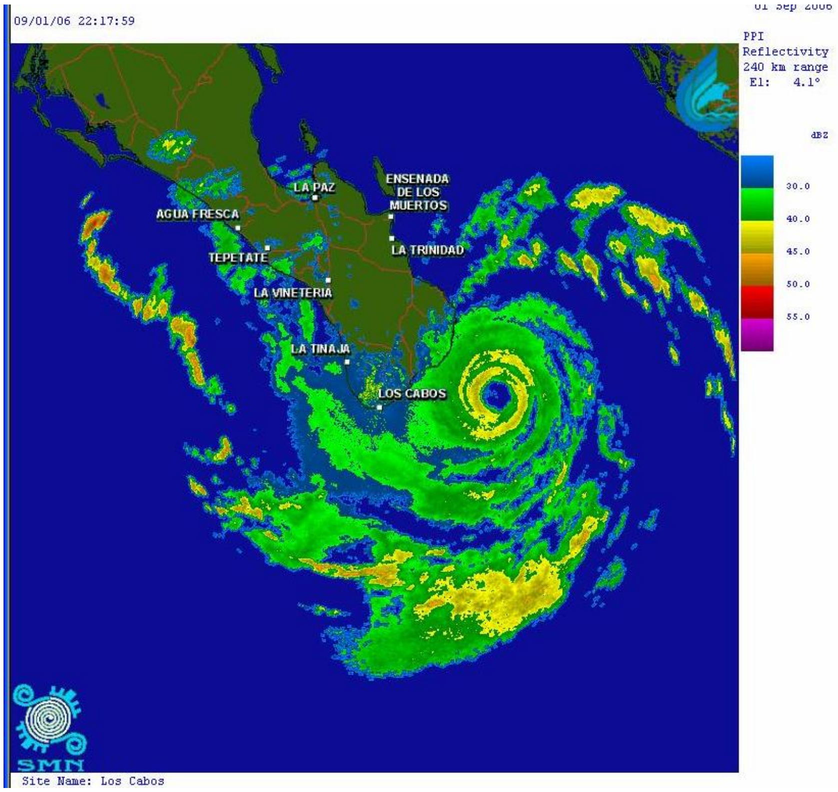


Figure 2 – Radar image of Hurricane John *taken at Los Cabos, BCS on 1 September 2006*

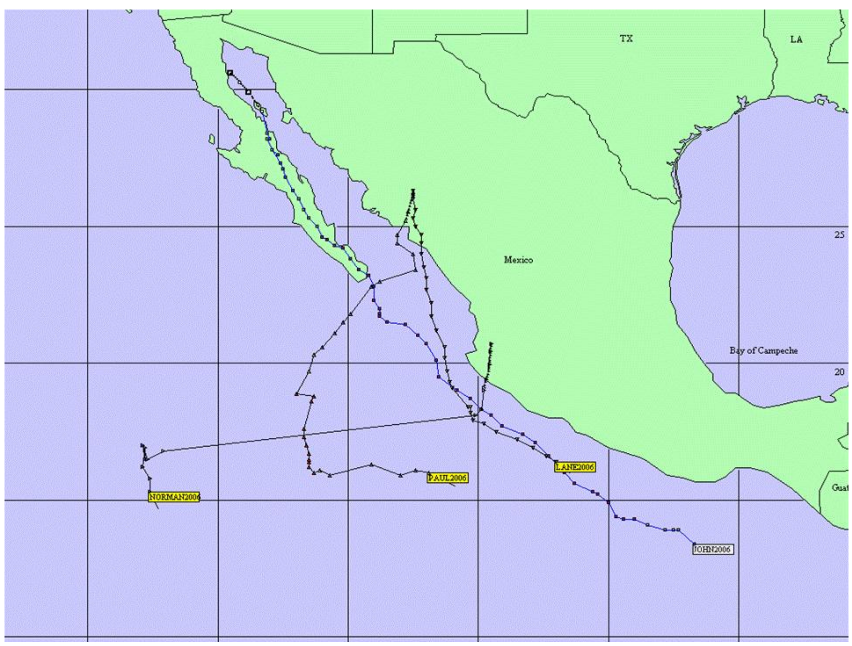


Figure 3 – Tracks of the tropical cyclones directly affecting Mexico during the 2006 season: Hurricane 2 John *(28 August to 4 September over Lower California South), Hurricane 3* Lane *(13-17 September over Sinaloa, Tropical Depression* Norman *(8-15 October over Jalisco, Colima and Michoacán) and Tropical Depression* Paul *(21-26 October over Sinaloa)*

SPAIN

The extratropical phase of Hurricane Gordon affected the land and offshore parts of northwestern Spain on 21 September 2006 after already crossing the Azores during 19 and 20 September as a hurricane. After that, it moved eastwards, keeping its tropical characteristics for most of its life cycle, despite moving over relatively cool (around 25°C) water. While moving quickly eastwards at a speed of 25-30 kt, Gordon had started weakening late on 19 September owing to a combination of lower sea-surface temperatures and increasing wind shear. Nevertheless, the extratropical phase of Gordon was significant, as winds of over 55 kt (102 km/h) were sustained for two days after the transition.

Late on 20 September, Gordon was under the influence of an active polar trough and started to lose much of the cloud symmetry typical of tropical cyclones (see satellite images below). The 18 UTC image in Figure 1 shows Gordon being absorbed by the active polar front approaching from the west. The extratropical transition can be seen from the uncoupling of two fundamental elements: the surface low of 992 hPa, B, and the very cold cloud tops, TF, located northeast of the low. This characteristic of the transition increased over the next few hours, as the surface low separated from the cold cloud top zone associated with convective rain, and the intense low-level winds together with the surface low slowed down with respect to the convective area to the north. This low (B) underwent a cyclogenetic process, with significant pressure drops over a short period.

The image for 21 September at 06 UTC shows the compact cloud band of tropical origin north of Galicia, embedded in the frontal system, while the low to the west of the Galician coast was deepening. During the early hours of 21 September, it brought high winds over the northwestern part of the Iberian Peninsula, with hurricane force gusts of up to 89 kt (165 km/h) over parts of the Galician coast, and over 63 kt (120 km/h) in many places.

An important indication of the magnitude of the cyclogenesis is the surface pressure measured at A Coruña observatory every 3 hours on 20 and 21 September (see table below). In the six hours between 00 and 06 UTC on 21 September, the pressure dropped 11.6 hPa, and 17.1 hPa in 12 hours.

Date/time (UTC)	20/18	20/21	21/00	21/03	21/06	21/09
Pressure (hPA)	**1006.8**	**1004.8**	**1001.3**	**996.2**	**989.7**	**996.6**

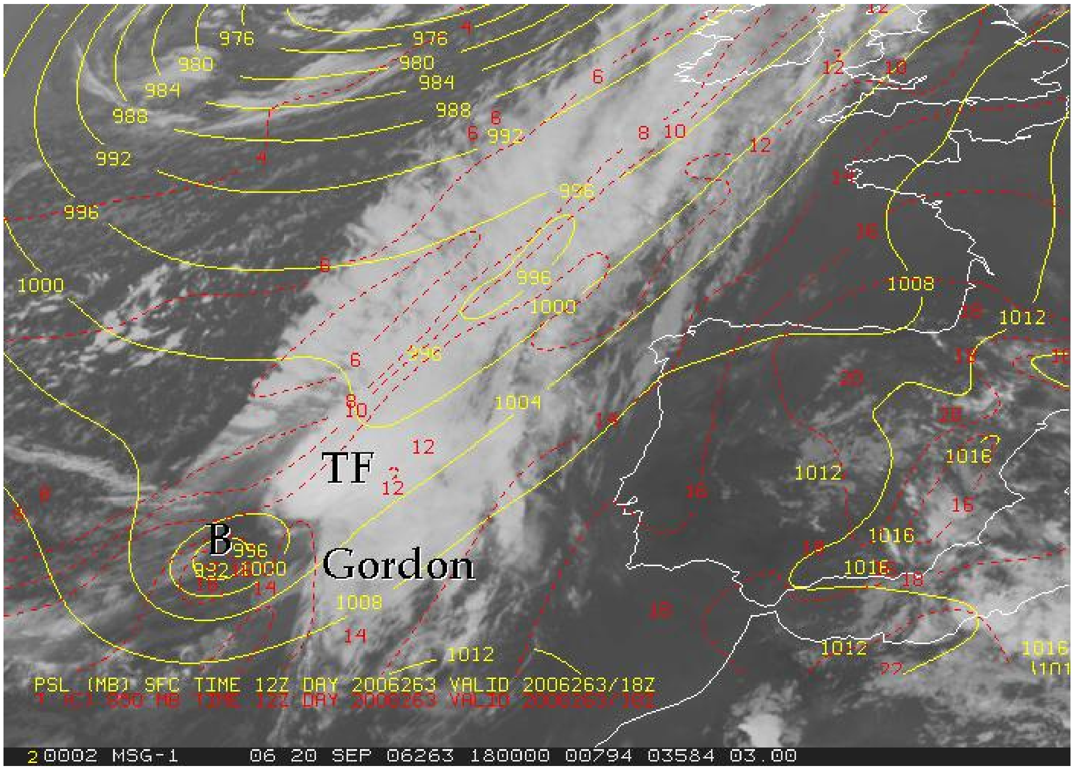


Figure 1 –Infrared image from the Meteosat 8 10.8 µm channel, 20 September 2006 at 18 UTC. Surface pressure (hPa, continuous line) and 850-hPa temperature (ºC, dashed line) from the ECMWF model, run 20/09, 12 UTC, H+6

The Spanish Meteorological Service (INM) issued special tropical storm warnings as from 18 September. The warnings were consistent with the information provided by the NHC in Miami, indicating a high probability of hurricane force winds in coastal zones, a violent storm and very high sea in the offshore areas of northwest Spain. As from 20 September, the short-range warnings gave the maximum alert level (red level) in Galicia and its offshore area for the first half of 21 September (see Figure 3).

The INM's new warning plan, which has been in operation since July 2006, enables the INM to issue special tropical storm warnings when the NHC forecasts tropical storms close to Spain (within a radius of 1,000 km) for the next two days.

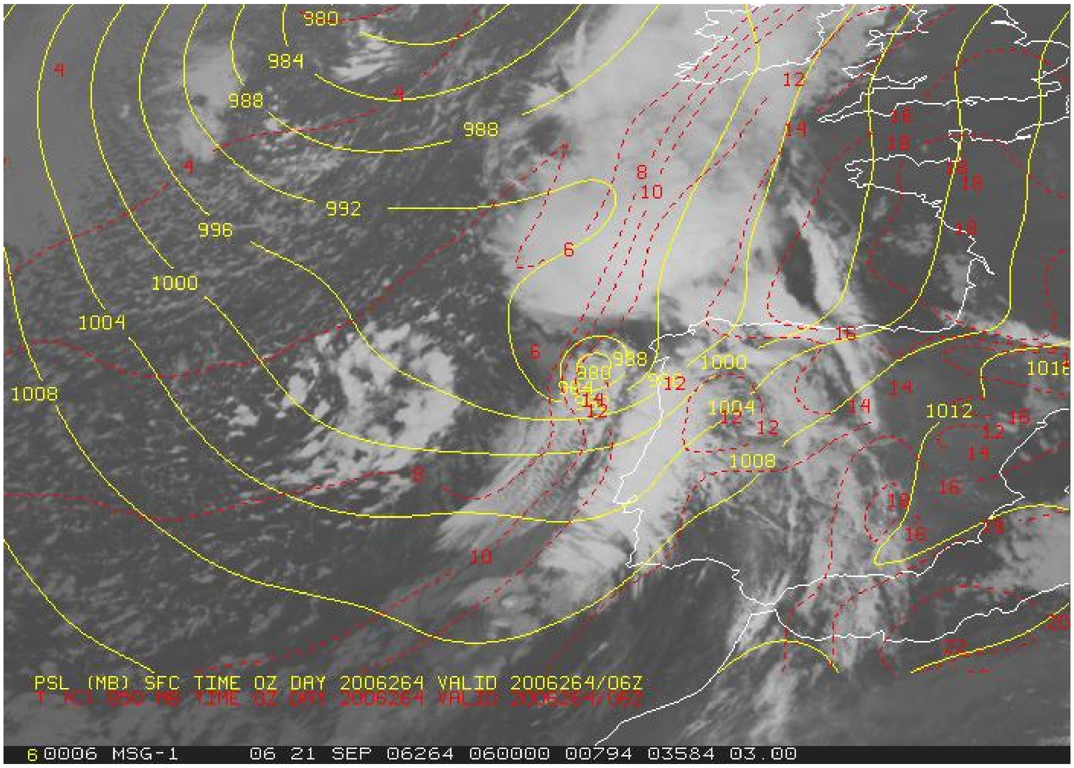


Figure 2 – Idem for 21 September at 06 UTC, ECMWF, run 21/09 00 UTC, H+6

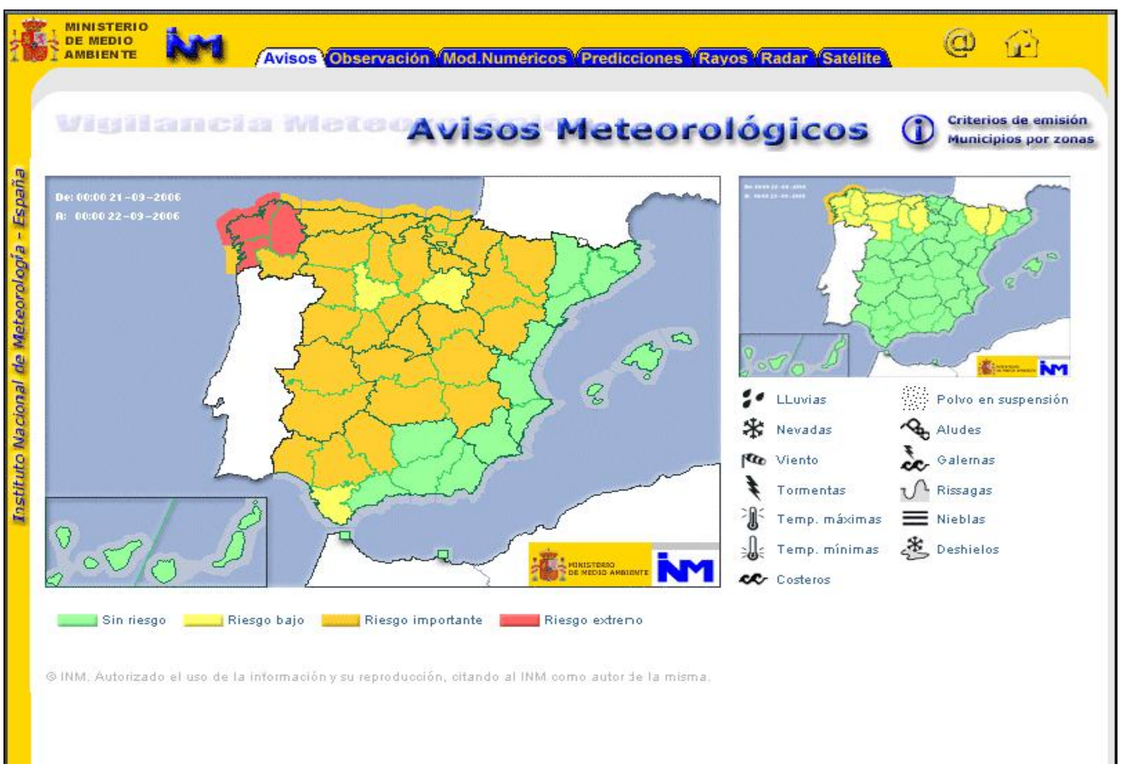


Figure 3 – INM warnings webpage for 20 September 2006. The red level warning was issued for several areas in Galicia, with wind gusts of over 130 km/h forecast for 21 September

TRINIDAD & TOBAGO

Synoptic Branch
Piarco International Airport
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The 2006 Atlantic hurricane season was not a very active season in general and created no direct problems for the twin islands of Trinidad and Tobago. All tropical cyclones which formed in the Atlantic Basin passed to the north of Trinidad and Tobago, as such there was no direct impact from any cyclones. However, during one of the severe weather episodes of the season one person died as the result of a lightning strike.

Several severe weather episodes occurred over Trinidad and Tobago during the hurricane season and can be attributed to the passage of Tropical Waves and ITCZ dominance. Also, the passage of tropical cyclones well to the north of the Islands of the Eastern Caribbean, results in a weakening of the low/mid level wind-field over Trinidad. Temperatures soars in excess of 34 degrees Celsius and this results in localized convergence which produces torrential showers from midday to early afternoon, resulting in flash flooding in Port-of-Spain and environs during the months of October and November. It was one of these episodes that produced the cumulonimbus cloud from which the fatal lightning strike occurred.

APPENDIX V

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

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
1.2.2	Upper-air stations								
1.2.2.1	Establishment of the following upper-air stations: ✐ Guatemala ✐ 80400 Isla de Aves - radiosonde						Guatemala Venezuela	) National and) external) assistance	
1.2.2.2	Implementation of two radiowind observations per day at all radiowind stations throughout the hurricane season*						Members concerned	National and external assistance	
1.2.2.3	Maintaining two radiowind observations per day whenever a named hurricane is within 1,000 km of the station, until the requirements of paragraph 1.2.2.2 above can be accomplished*						Members	National	

Colombia upper-air station now operational

*During 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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 2007-2008 items with an asterisk to be given priority attention

** concern expressed regarding disclosure of ship position due to security reasons

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
1.2.4	Automatic weather stations								
1.2.4.1	Exploration of the possibility of installing automatic reporting devices at stations with insufficient staff for operation throughout the 24 hours; such stations might then be operated during daylight hours as manned stations and during night-time as unattended automatic stations, possibly with a reduced observing programme						Members concerned	National and external assistance	
1.2.4.2	Exploration of the possibility of installing automatic weather stations at locations which may be considered critical for the hurricane warning system for operation at least during the hurricane season						Members concerned	National and external assistance	

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE 2007	2008	2009	2010	2011	BY WHOM	RESOURCES	COMMENTS
1.2.4.3	Establishment of automatic weather stations at the following locations:								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
	Dominican Republic (18)	—	—	—			Dom. Rep.	National & USA	
	Colombia (35) *	—	—	—			Colombia	National and external assistance	
	Bermuda (6)	—	—				Bermuda		
	Honduras (6)	—	—				Honduras		
	Panama (21)	—	—						
	Guatemala (31)	—	—						
	Cuba (30)	—	—						

(1) The Dominican Republic has installed 13 automatic weather stations and has requested that the time scale for the remaining 18 be extended to 2009.

(2) Colombia has installed 150, 9 in the Caribbean area. The remaining 35 are expected to be installed by the end of 2008.

(3) Bermuda has completed its tasks; however, only the 3 onshore stations are working properly. The other 3 are experiencing battery and communication problems.

(4) Honduras has 3 operational stations at Tegucigalpa, 1 at Swan Island (no modem), 6 to be installed by 2009.

(5) Data is currently being received from recently installed automatic weather stations in St. Vincent and the Grenadines.

* During 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
1.2.5	Radar stations								
1.2.5.1	Promotion of the establishment and operation of a sub-regional network of 10 cm/5.6 cm wavelength radar stations, including replacement of unserviceable radars* • Replacement of radars in Barbados, Belize, Trinidad & Tobago • Replacement of radar in St. Marteen						Barbados, Belize,Trinidad &Tobago Netherlannd Antilles	National and European Union	Being implemented
1.2.5.2	Establishment and operation of 10 cm/5.6 cm wavelength radar stations at the following locations or nearby: • On the Central American coast (within longitudes 82° and 92°W and latitudes 10° and 16°N) either in Central America • Mexico (1) at Chiapas • Honduras (1) • Guatemala (1) • Venezuela (3 more)						Costa Rica, Nicaragua, El Salvador. Guatemala Venezuela	)))) National and) external) assistance))	CRRH developing a project for Central America

*During 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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	

Meteo France is providing mosaics on its website and a dedicated FTP Server.

Note on 1.2.5.2 Venezuela has completed its tasks but radars are experiencing software problems. These problems are expected to be resolved by 2008.

* During 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
1.2.7	Meteorological satellite systems**								
1.2.7.1	Maintaining and operating the LRIT stations for the reception of cloud pictures from GOES and near-polar-orbiting satellites, including any modified or new equipment necessary for the reception of information from the POES series of satellites*						Members	National	
1.2.7.2	Installation and operation of direct read-out satellite reception facilities, in view of their great utility in hurricane tracking and forecasting*						Members able to do so	National and external assistance	
1.2.8	Storm surges								
1.2.8.1	Establishment of a network of tide-gauge stations in coastal areas where storm surges are likely to occur						Members able to do so	National	Data should be provided in near real-time

*During 2007-2008 items with an asterisk to be given priority attention

** Satellite technology has increased tremendously; met services should explore products

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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 recommende d
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
		2007	2008	2009	2010	2011			
1.3.3	Regional telecommunication network								
1.3.3.1	Continue to improve and upgrade telecommunication systems in accordance with the RA IV Regional Meteorological Telecommunication Plan,*						Members		
1.3.3.2	Promote installation of EMWIN systems						USA Members	External Assistance & National budget	

*During 2007-2008 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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		

CIMH has delivered storm surge atlases for Cayman Islands, Trinidad and Tobago and Grenada.

*During 2007-2008 items with an asterisk to be given priority attention

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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
		2007	2008	2009	2010	2011			
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:							National	
	(a) The countries indicated to be invited to consider the establishment/ expansion of systems in the:								
	• YAQUE DEL SUR river basin	—	—	—			Dominican Republic		
	• YAQUE DEL NORTE river basin	—	—	—					
	• RIO LEMPA	—	—	—	—	—	El Salvador and Honduras Guatemala		
	• International river, RIO GRANDE (RIO BRAVO) river basin	—	—	—	—	—	Mexico & USA		Additional data required
	• VIEJO,COCO and TUMA river basins	—	—	—	—	—	Nicaragua		
	• RIO PARRITA and RIO ESCONDIDO	—	—	—			Costa Rica		

Rio Lempa has been established with assistance from NOAA.

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
2.2.1 (cont'd)	Establishment, improvement and/or expansion of hydrological forecasting (including flash floods) and warning systems in flood-prone areas, and in particular:								
	(b) Establishment of flash flood warning systems in flood-prone areas;						Members concerned	National	
	(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
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	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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
		2007	2008	2009	2010	2011			
2.3.6	Initiation of research studies and operational data collection for analysis and forecasting of combined effects of storm surge and river flooding phenomena** ** WMO Operation Hydrology Report No. 30 "Hydrological Aspects of Combined Effects of Storm Surges and Heavy Rainfall on River Flow"						Members	National and external assistance	For these studies, use should be made, insofar as possible, of previous experience of Member countries of the Committee
2.3.7	Basic studies on the vulnerability of the monitoring networks to damage caused by tropical storms, taking into account also the problems which might be generated when stations become inoperative, both with regard to the interruption of the available historical series and to the provision of observations and data of subsequent events						Interested Members	National and TCDC	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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	

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
2.4 TRANSFER OF HYDROLOGICAL TECHNOLOGY									
2.4.1	Attention to the availability through HOMS of components and sequences containing hydrological technology suitable for the hydrological component of the technical plan*						Members	National and TCDC	With advice of WMO
2.4.2	Undertaking a promotional effort among Member countries, so that they may develop HOMS components reflecting in particular experiences in regions affected by tropical storms; the Committee to encourage the inclusion of the components in the HOMS Reference Manual						Hurricane Committee in cooperation with its Members	National and TCDC	

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

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

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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	Members are encouraged to collaborate with ISDR
3.1.3	Participate actively in appropriate conferences and activities related to natural hazard mitigation and multi-hazard warning systems.						Members	National, regional and international	
3.1.4	Participate actively in the preparation and on-going review of the national disaster prevention and preparedness plans						Members	National	
3.1.5	Cooperate with all national and regional agencies in their annual pre-hurricane season exercises. Where these do not exist meteorological services should promote their implementation						Members	National and regional	

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
3.1.6	Promote good relationship with the media and make full use of their services to disseminate information prior to and during the hurricane season						Members	National, regional and international	
3.1.7	Arranging for the early transmission of forecasts of hurricanes and flooding to the central coordinating agency responsible for the organization of protective and relief measures, and to similar coordinating agencies at regional level, to allow the timely dissemination of warning by such agencies						Members	National and regional	
3.1.8	Participate in ensuring that official advisory statements concerning forecasts, warnings, precautionary actions or relief measures are only to be made by authorised persons and to be disseminated without alteration						Members	National, regional and international	
3.1.9	Advising on and contributing to training programmes to support preparedness programmes to include disaster administrators, disaster control executives and rescue/relief groups and workers in all counter-disaster authorities and agencies						Members	National, regional and international	

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
3.2 REVIEWS AND TEST EXERCISES									
3.2.1	Participating in periodic reviews of both disaster prevention and disaster preparedness plans to ensure that they are active and up to date						Members	National and external assistance	With advice of OCHA/IFRC/ CDERA
3.2.2	Conducting of periodic staff checks and test exercises to test the adequacy of NMHSs disaster preparedness plans, preferably on a progressive annual basis prior to the expected seasonal onset of natural disaster threats but also, in respect of plans to meet sudden impact disasters, on an occasional no-warning basis						Members	National	

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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 Desk in Washington.						Members	National and external assistance	

*During 2007-2008 items with an asterisk to be given priority attention

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
4.1.3	Arrangements for short courses of approximately 2 to 3 weeks duration on topics related to storm rainfall estimation and to hurricane forecasting to be organized at the RSMC Miami Hurricane Center and the Regional Meteorological Training Centres at the CIMH and the University of Costa Rica*						Regional centres	Regional, national and external assistance	These events should be conducted in English and Spanish
4.1.4	Arrangements for periodic seminars or workshops on specific topics of particular interest for hurricane prediction and warning purposes, priority being given in the first instance to operational techniques for the interpretation and use of NWP products, satellite and radar data and to storm surge prediction						Members, Hurricane Committee	National and external assistance	
4.1.5	Arrangements for exchange working visits of Staff between operational and training centres						Members, training centres	National and external assistance, regional projects, TCDC	

*During 2007-2008 items with an asterisk to be given priority attention

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2007	2008	2009	2010	2011			
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	
	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
		2007	2008	2009	2010	2011			
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
		2007	2008	2009	2010	2011			
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 2007-2008 items with an asterisk to be given priority attention

APPENDIX VI

LIST OF VCP PROJECTS RELATED TO RA IV HURRICANE COMMITTEE MEMBERS