WORLD METEOROLOGICAL ORGANIZATION

RA IV HURRICANE COMMITTEE

THIRTY-FOURTH SESSION

PONTE VEDRA BEACH, FLORIDA, USA

(11 to 15 April 2012)

FINAL REPORT

1. ORGANIZATION OF THE SESSION

At the kind invitation of the Government of the United States of America (USA), the thirty-fourth session of the Regional Association (RA) IV Hurricane Committee was held in Ponte Vedra Beach, Florida, USA from 11 to 15 April 2012. The opening ceremony commenced at 09.00 hours on Wednesday, 11 April 2012.

1.1 Opening of the session

1.1.1 Mr Bill Read, Chairman of the RA IV Hurricane Committee, welcomed the members to Jacksonville for the thirty-fourth session of the Committee. He thanked them for their diligence in preparing for the important matters to be considered. Mr Read then welcomed Raytheon, who was displaying the new AWIPS II system currently being implemented by the US National Weather Service (NWS), and being considered for implementation for the National Meteorological Service of Mexico. Mr Read welcomed and thanked Sutron for their generous support of the meeting through sponsorship of the coffee breaks and welcome reception. Mr Read finished by expressing appreciation for the interpreters for the work they did to make our multiple language formats succeed.

1.1.2 On behalf of Mr Michel Jarraud, Secretary-General of the World Meteorological Organization (WMO), Mr Koji Kuroiwa, Chief of the Tropical Cyclone Programme (TCP), expressed the sincere appreciation of WMO to the Government of the United States for hosting the thirty-fourth session of the Committee. Mr Kuroiwa extended his gratitude to Dr Jack Hayes, Permanent Representative of the United States with WMO and his staff for the warm welcome and hospitality and for the excellent arrangements made to ensure the success of the session. Referring to the WMO's provisional statement issued in November 2011 which showed that global temperatures in the year were the tenth highest on record, Mr Kuroiwa emphasized that climate variability and change should increasingly modify the relative magnitude of disaster risks, which would be especially critical in coastal areas on account of altered storm patterns and sea-level rise. In this regard, he stressed the necessity of establishing the multi-sectoral preparedness and prevention as part of overall national development programmes. Such development of the risk management of disasters emphasized the increasing need for more reliable and longer lead-time hydro-meteorological information as well as for closer linkage between the disaster agencies and relevant sectors. Under these circumstances, Mr Kuroiwa encouraged the participants to renew their awareness that the Committee was expected to play an ever-greater role in the reduction of disaster risks for the people in the Region and expressed his expectation that the thirty-fourth session would develop concrete actions to meet the requirement. In expressing WMO's continued support for the Committee's programmes, he wished the participants a very successful session and an enjoyable stay in Ponte Vedra Beach.

1.1.3 Mr Juan Carlos Fallas, Vice-President of WMO RA IV, welcomed the members of the Committee on behalf of the President of RA IV, Mr Arthur Rolle, who was unable to participate in the meeting but wished the participants effective and fruitful discussions, as it had always characterized the work of the Committee. Mr Fallas highlighted that each meeting of the Committee had an indisputable aim and objective: to improve, every year, the work of the National Meteorological and Hydrological Services (NMHS) through the Hurricane Operational Plan and through learning in order to safeguard the life of their fellow citizens. Mr Fallas said that it was for this reason that the work of the Committee would always be successful, its aim being the good of society and, thus, its work had a human dimension. The sole fact of saving a human life, through the work of the Committee, was a gratifying endeavour for everyone and for God. In addition, he highlighted the importance of the Caribbean Hurricane Awareness Tour (CHAT) through the Hurricane Hunter aircraft. Such visits had far-reaching and positive effects and facilitated the mitigation and communication work of Services. Mr Fallas said that there was no other activity that achieved such a success. He reaffirmed that the CHAT was the perfect complement in the implementation of the Hurricane Operational Plan. For this reason, he urged his colleagues that, as an objective for the current year, the Government of the United States be requested to continue such support work for the good of the people of the Region. Mr Fallas, on behalf of the members of the Committee, thanked Mr Bill Read, Director of the National Hurricane Center (NHC) in Miami, on the occasion of his impending retirement for his support, work and dedication during his term as Chairman of the Hurricane Committee. He also thanked Lt. Col. David Borsi, Air Force pilot, who was also retiring. He congratulated Ms Courtney Draggon on her appointment as Director of the US NWS International Activities Office (IAO). Lastly, Mr Fallas expressed his gratitude to the Government of the United States and to WMO as hosts of the meeting for making possible the thirty-fourth session of the RA IV Hurricane Committee.

1.1.4 Ms Courtney Draggon welcomed the members to Jacksonville for the thirty-fourth RA IV Hurricane Committee meeting on behalf of Dr Hayes. She conveyed Dr. Hayes' regrets in not being able to open this important meeting. Ms Draggon described the RA IV Hurricane Committee as a pillar within the WMO community and stated its importance and significance to the US NWS. She expressed her confidence that this sentiment was shared by others in the Region and the WMO for it was during the last RA meeting that the Members changed the Region's working structures to be more flexible and responsive to Member's needs. The Region ensured that one body, the RA IV Hurricane Committee, was preserved above others as it served a critical function to all Members. Ms Draggon stressed that the Hurricane Committee not only supported hurricane preparedness, monitoring and forecasting in the Region, it also unified all of RA IV and promoted a cooperation and collaboration that extended beyond tropical cyclone events. Through this body, the members had agreed on how to coordinate and communicate with one another during times of pending disaster or uncertainty. Ms Draggon noted that this community had worked on wider WMO initiatives that brought benefit back into all its services, from building the capacity of our forecasters through training, whether it be at the Caribbean Institute for Meteorology and Hydrology (CIMH), the University of Costa Rica, the National Centers for Environmental Prediction (NCEP); the annual CHAT; or through regional projects, such as the radar mosaic under the leadership of the Caribbean Meteorological Organization (CMO). Ms Draggon also noted that it was that community that stood together to help in our most desperate times like when the devastating earthquake affected Haiti. It was this WMO community that had engendered a sense of spirit which must be preserved and strengthened. It was this example of community stemming from a WMO working body that must serve as a best practice. As with any good practice it must continually look to improve the way it functioned in an environment of shrinking resources and ever increasing need for timely and accurate weather information. The Region must look to see how this Committee could continue to grow the capacities of its members and improve its delivery of products and services. Ms Draggon concluded by reminding the Committee that as it spent the week preparing for the next season, agreeing on the Region's technical and operation plans as well as joining the American Meteorological Society's Conference on Hurricanes and Tropical Meteorology, it needed to keep in mind that it was the regional unity that made both the Committee and the Regional Association so successful as it prepared for the next quadrennial meeting.

1.1.5 The session was attended by 49 participants, including 32 from RA IV member States of the Committee, observers from Aruba and four regional and international organizations. The list of participants is given in **Appendix I**. Members of Raytheon Corporation participated in the session and provided participants the opportunity to view a demonstration of the AWIPS II system. The Committee also thanked Sutron Corporation for its participation and generous support of the session.

1.2 Adoption of the agenda

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

1.3 Working arrangements for the session

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

2. REPORT OF THE CHAIRMAN OF THE COMMITTEE

2.1 The Chairman reported to the Committee that during the 2011 hurricane season, Mr Wilson Falette from the Dominican Republic, and Mr Llewellyn Dyer from the Antigua and Barbuda Meteorological Services, participated in the WMO/Regional Specialized Meteorological Centre (RSMC) Miami attachment programme. The meteorologists helped with hurricane warning coordination in the Region during the tropical cyclone events while they gained valuable training in hurricane forecasting. RSMC Miami and WMO strongly encouraged WMO RA IV permanent representatives to continue to support this programme. The announcement requesting candidates for 2012 would be sent by the President of RA IV in April 2012.

2.2 Three meteorologists from the Mexican Air Force were stationed at the RSMC Miami during 2011. Captains Arnulfo Crispin Perez Ortiz, Eliseo Toral Salinas and Leonardo Alejandro Lopez Leon helped coordinate 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 urged the continuation of this programme in 2012 and a letter of invitation had been sent to the Mexican Air Force.

2.3 This year's WMO RA IV Workshop on Hurricane Forecasting and Warning and Public Weather Services was held at RSMC Miami from 12 to 23 March 2012 and was conducted in English and Spanish. The Chairman strongly supported the practice that the Workshop continued to be offered in English and Spanish every other year due to the importance to the Region’s hurricane programme. In addition, Dr Lixion Avila participated in a Hurricane Forecasting Workshop in the Dominican Republic and in El Salvador during May 2011 and February 2012, respectively.

2.4 From 16 to 19 November 2011, Dr Cristina Forbes, an oceanographer and numerical modeller at the NHC Storm Surge Unit, attended the WMO Stakeholders Technical Workshop for the JCOMM-CHy Coastal Inundation Forecasting Demonstration Project (CIFDP) in Santo Domingo, Dominican Republic, as an invited storm surge modelling expert. The workshop was held in Spanish and was well attended involving participants from many different local and foreign institutions. Dr Forbes presented a talk entitled "An Introduction to the SLOSH Modelling System" then developed and presented a draft plan to establish a new storm surge prediction system in the Dominican Republic.

2.5 The Latin America Caribbean Hurricane Awareness Tour (LACHAT) took place from 12 to 17 March 2012. The US Air Force C-130 (J-model) Hurricane Hunter plane visited Campeche and Chetumal, Mexico, Limon and San Jose Costa Rica, Sint Maarten and Puerto Rico. LACHAT was devoted to increase public awareness of the hurricane threat and would serve to recognize and strengthen national and international teamwork for storm warning and emergency response. The LACHAT had enhanced the visibility of the participating countries’ weather forecasting and emergency management offices. Over 15 thousand people toured the plane in 2011.

2.6 Reconnaissance aircraft played an extremely important role in monitoring the track and intensity of tropical cyclones. During the 2011 season, the US Air Force and the National Oceanic and Atmospheric Administration (NOAA) reconnaissance hurricane aircraft provided valuable meteorological data not available from any other sources.

2.7 RSMC Miami greatly appreciated the radar imagery received operationally from RA IV members during the 2011 hurricane season. The Chairman encouraged NMHSs to continue to make radar imagery from the Region available operationally via the Internet or any other possible way.

2.8 Surface- and upper-air observations were very important to the operational forecasts of the RSMC Miami. The Chairman appreciated the members' efforts to maintain their observation and communication systems, especially the data received from countries during tropical cyclone events.

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

2.10 Coordination between RSMC Miami and the US Department of State Crisis Operations Center during hurricane events in 2011 was helpful in communicating forecasts with the US Embassies in the RA IV countries.

2.11 As part of the United States Weather Research Program (USWRP), the Joint Hurricane Testbed was one of the primary avenues to evaluate research projects with the goal of transitioning successful projects into operations. There were 12 on-going projects which would be evaluated during the upcoming 2012 hurricane season.

2.12 The NOAA Hurricane Forecast Improvement Program (HFIP) was a multi-agency effort to improve tropical cyclone track and intensity forecast accuracy by 50% over a ten-year period. The promising preliminary results noted in 2010 when inner core data were assimilated into a high resolution model were now seen in a second model. Intensity forecast improvements of 5-30% occurred with the data in the 36-120 hour period. Other progress was being noted as well and with HFIP's support, for example, the operational Hurricane Weather Research and Forecasting (HWRF) model would soon add a high resolution inner nest. RSMC Miami remained actively involved in leading aspects of HFIP. The procedure whereby promising output was made available in real or near real time for the specialists was in place.

2.13 The Director of RSMC Miami and Dr Lixion Avila would be expected to participate in the 7th RSMC/Tropical Cyclone Warning Centre (TCWC) Technical Coordination Meeting (TCM-7), which would be held in Indonesia from 12 to 16 November 2012.

2.14 During the 2011 meeting of the RA IV Hurricane Committee, an alternative mode of coordinating with the Meteorological Services of the Region via Internet was proposed. Unfortunately, technical issues prevented proper testing during the last season. An alternative method would be explored by RSMC Miami during the 2012 hurricane season.

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

2.16 NOAA trained six fellows from Central America and six from the Caribbean each year at the Tropical Desk at the National Centers for Environmental Prediction Hydrometeorological Prediction Center (NCEP HPC). Fellows were trained on operational skills, including numerical weather prediction techniques. In addition, the Spanish-speaking chief instructor for the Tropical Desk delivered week-long specialized training courses for officials in Mexico last year and, this year, in El Salvador.

2.17 The Hurricane Attachment Programme brought National Meteorological Service (NMS) personnel from vulnerable members States to train on forecasting, preparedness, and public outreach during the hurricane season. Three participants would be trained during the hurricane season.

2.18 Support was provided for the organization of an RA III/RA IV Workshop on Implementing Competency Assessment for Aeronautical Meteorological Personnel as part of the activities of the RA IV Task Team on Aviation. The workshop took place in August July 2011, at the Caribbean Institute for Meteorology and Hydrology (CIMH) in Barbados.

2.19 NOAA continued to support climate workshops and climate adaptation training in the Caribbean, led by NWS's senior climate specialists.

3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME

3.1 The Committee noted that the Sixteenth World Meteorological Congress, which was held in May 2011, gave the following guidance to TCP:

- To assist Members in their efforts to implement Tropical Cyclone Programme activities for the safeguard of life and property from tropical cyclones and related hazards to the maximum extent possible within the available budgetary resources;
- To continue to support the capacity building programmes for developing countries, especially for Least Developed Countries and Small Island Developing States;
- To maintain and further enhance the collaboration between the Tropical Cyclone Programme and relevant WMO Programmes and technical commissions, particularly in relation to the development of tropical cyclone forecasting competencies;
- To continue close cooperation with other international as well as relevant national organizations at the global and regional levels to promote a multidisciplinary and multi-hazard approach towards the attainment of the humanitarian goals of the Programme.

3.2. The Committee noted that two TCP/Public Weather Services (PWS) joint training workshops were successfully conducted during the intercessional period - Southern Hemisphere Training Course on Tropical Cyclones and Training Workshop on PWS (Melbourne, Australia, 5-23 September 2011) and RA IV Workshop on Hurricane Forecasting and Warning and PWS (Miami, Florida, USA, 12-23 March 2012). It also noted with pleasure that a provisional evaluation analysis showed that most of the participants gave high marks for the RA IV Workshop in 2012 and that the primary objectives of the workshop were accomplished. The Committee expressed its gratitude to RSMC Miami for hosting the annual workshop and reiterated its key contribution to the capacity development of the Committee members.

3.3 The Committee noted that the Global Guide to Tropical Cyclone Forecasting had been updated toward an early publication during 2012. The new Guide would be mainly Web-based for widespread access by forecasters and researchers around the globe and a limited number of hard copies would be also distributed to the WMO Members and WMO Regional Training Centres (RTCs) in the tropical basins. It would achieve synergetic effect with the tropical cyclone forecaster Website which was also under construction to provide useful tools and data for operational forecasters. In this respect, the Committee noted with pleasure that Hong Kong, China agreed to host the tropical cyclone forecaster Website in response to the request of WMO. The Website was expected to be launched late in 2012. In view of its significance for the operational forecasters, the Committee requested the WMO Secretariat to publish the new Global Guide in different languages.

3.4 The first WMO International Workshop on the Satellite Analysis of Tropical Cyclones (IWSATC) was organized in Honolulu, Hawaii, USA from 13 to 16 April 2011 in collaboration with the WMO World Weather Research Programme (WWRP) and the National Climatic Data Center (NCDC) of NOAA. It was held in conjunction with the 2nd workshop of the International Best Track Archive for Climate Stewardship (IBTrACS) which was run by NCDC. Linking with the effort to produce a globally-unified best track dataset, IWSATC set out to promote the sharing of expertise in satellite analysis of tropical cyclones between forecasters and researchers and helped facilitate their discussions on its future improvement.

3.5 Recognizing that satellite analysis formed a vital portion in the monitoring of tropical cyclones while advanced analytical tools and data were becoming available via the Internet, the Committee requested the WMO Secretariat to establish the new tropical cyclone forecaster Website in full consideration of inclusion of those tools and data. Noting also the strong requirement of the Committee members for further improvement of their satellite-based tropical cyclone analysis techniques, the Committee urged the WMO Secretariat to conduct a training workshop for tropical cyclone satellite analysis on an early date as recommended by the IWSATC.

3.6 In relation to the requirement of training in satellite analysis in the Region, the Committee paid close attention to the activities of CIMH in the training for the meteorologists in the Region. In this regard, CIMH emphasized the establishment of competency-based standards for operational aeronautical forecasters by WMO, which initiated the need for meteorological services to seek immediate and effective training for their operational forecasters. CIMH, as RTC and the Centre of Excellence (CoE) in satellite meteorology, was currently working on and developing programs to train and assist operational forecasters.

3.7 As a CoE, CIMH supported Virtual Laboratory for Training and Education in Satellite Meteorology (VLab) activities such as regional satellite focus group online discussions, which were developed to both instruct and aid forecasters in satellite interpretation. An important aspect of this training was the inclusion of satellite interpretation in the process of tropical cyclone analysis and forecasting. Also in collaboration with the University Corporation for Atmospheric Research/Cooperative Programme for Operational Meteorology Education and Training (UCAR/COMET®), CIMH formulated an online Aeronautical Continuing Professional Development (AeroCPD) course. The course immediately addressed the competency issues and enhanced continuing on-the-job-training in new technologies critical to operational forecasting. The main areas covered were: satellite interpretation; radar meteorology; numerical weather prediction using mesoscale models; and aeronautical meteorology. CIMH remained committed to serve the Region by developing near innovative curricula.

3.8 Noting the intense activities of CIMH as above, the Committee recommended the WMO Secretariat to make closer linkage with CIMH for developing synergies to enhance ability of operational meteorologist in satellite analysis in the Region.

3.9 Prof. Don Resio, Co-chair of the WMO Coastal Inundation Forecasting Demonstration Project (CIFDP), provided an introduction to the purpose and work conducted under this WMO effort. The presentation emphasized the focus of the CIFDP on capacity building for storm surge predictions within a country. It also touched on a number of topics including the need for this type of project in light of the ever-increasing exposure of coastal areas to catastrophic flooding related to climate change and rising sea level. It showed how the forecasting and warning systems and the storm surge modelling planned for the CIFDP fitted into a general scheme for end-to-end management of coastal inundation. It showed that this required a complete set of in-country capabilities including 1) baseline topography/bathymetry; 2) observations, operational open source models; 3) adequate training and 4) risk analysis and decision support tools. The presentation discussed the importance of building a unified collaborative effort within a definitive national agreement and the need to meet specific stakeholder requirements for that nation, while ensuring the application of best practice methods and models. Additionally, the CIFDP was expected to help develop an integrated forecast system with coupled models of all significant processes influencing inundation in coastal areas (direct wind-driven storm surge, wind waves, tides, and river discharge).

3.10 The CIFDP effort would be implemented in a phased approach that provided flexibility to adapt the program as it evolved. The stages of the program were 0) project preparation, 1) information gathering & adaptation to meet local needs, 2) system development and implementation, 3) pre-operational testing and validation, and 4) live running and evaluation. The linkage between ongoing research and development (R&D), particularly in the areas of improved modelling methods and enhanced observations (including those from satellite sources) was discussed; and the two ongoing CIFDP efforts in Bangladesh and the Dominican Republic were described. Although the CIFDP effort was specifically designed for implementation within individual countries, it was expected that some key coordination elements would be inherent in this effort, including linking the CIFDP effort to the RA IV Storm Surge Watch Scheme (SSWS), helping to establish standards for best practices within a larger region and assisting in developing a framework for international coordination. The final part of the CIFDP presentation provided information of the potential role of RSMC Miami in surge prediction in the Dominican Republic.

3.11 The overall CIFDP concept would not be limited to a country but approached regionally. In the meantime, the CIFDP implementation would be through each national sub-project like CIFDP-DR (Dominican Republic), driven by national requirements and users' need for an improved and integrated forecasting system. The Committee noted that any member of the Region that intended to develop a CIFDP national sub-project could prepare and deliver to WMO Secretariat an initial national agreement (between responsible national agencies for forecasting and warning of coastal inundation, such as storm surges, waves, coastal lowland flooding), in order for WMO through the Project Steering Group to consider the initiation of a sub-project.

3.12 A particular discussion point at the end of the presentation emphasized the need to develop close coordination between ongoing tsunami warning efforts within the WMO and the CIFDP effort; and it was agreed that the CIFDP had been attempting to do this and would continue to do so. Also at the conclusion of the presentation, the Representative from the Dominican Republic provided a valuable update pertaining to progress on the development of the definitive national agreement for the application of the CIFDP with the Dominican Republic. This agreement now seemed to meet all the requirements to be signed/established.

4. REVIEW OF THE PAST HURRICANE SEASON

4.1 Summary of the past season

4.1.1 A report of the 2011 hurricane season in the North Atlantic basin and in the Eastern North Pacific was presented to the Committee by Dr Lixion Avila, Senior Hurricane Specialist, on behalf of RSMC Miami - Hurricane Center.

4.1.2 The 2011 Atlantic hurricane season was marked by above average tropical cyclone activity with the formation of 19 tropical storms, of which 7 became hurricanes. Four of the hurricanes strengthened into major hurricanes (category 3 or higher on the Saffir-Simpson Hurricane Wind Scale). The numbers of tropical storms, hurricanes and major hurricanes were each above the long-term average (1981-2010) of 12, 6, and 3 respectively. In terms of the Accumulated Cyclone Energy (ACE) index, 2011 had 137% of the long-term median ACE. Similar to 2010, there was a tendency for a middle-latitude trough to become established along the United States east coast forcing many of the tropical cyclones to turn northward well east of the United States eastern seaboard. Irene was the exception, and was the only hurricane to affect the United States in 2011. Cindy, Franklin, and José were short-lived tropical storms that formed in the subtropical Atlantic and moved northeastward over open waters.

4.1.3 Tropical cyclone activity during the 2011 eastern North Pacific season was near average. Of the 11 tropical storms that formed, 10 became hurricanes and 6 reached major hurricane strength (category 3 or stronger on the Saffir-Simpson Hurricane Wind Scale). For comparison, the 1981-2010 averages are about 15 tropical storms, 8 hurricanes and 4 major hurricanes. Although the number of named storms was below average, the number of hurricanes and major hurricanes was above average. In fact, since so many recent years had been below average, 2011 had the most number of hurricanes since 2006, and the most number of major hurricanes since 1998. In terms of the ACE index, which is a measure that takes into account both the strength and duration of the season's tropical storms and hurricanes, 2011 had about 113% of the long-term median value of ACE. Like most years in the basin, the bulk of the cyclone activity remained offshore of the Mexican and Central American coasts (Figure 6). However, hurricane Beatriz affected the southwestern coast of Mexico in late June, likely bringing category 1 hurricane conditions to the coast. Jova made landfall in the same region in mid-October as a category 2 hurricane, causing a large area of damage and six deaths. In addition, short-lived tropical depression Twelve-E produced torrential rains over Guatemala, causing 36 deaths in that country, 34 deaths in El Salvador and 18 deaths in Honduras.

4.1.4 The Committee was informed that during the 2011 Atlantic hurricane season, buoy data indicated that intensity of hurricane Katia was stronger than that provided by the Dvorak technique. Since the Dvorak technique was developed in the 1970's and was last updated in 1984, RSMC Miami was asked if there were any plans to update the technique using satellite imagery of newer cyclones. It was indicated that some universities were trying to update the Dvorak technique using newer satellite data such as microwave, without much success thus far. However, new results may be presented during the American Meteorological Society's thirtieth Conference on Hurricanes and Tropical Meteorology, which would be held from 15-20 April 2012.

4.1.5 The detailed report on the 2011 hurricane season provided by the RSMC is given in **Appendix III.**

4.2 Reports on hurricanes, tropical storms, tropical disturbances and related flooding during 2011

4.2.1 Members provided the Committee with reports on the impact of tropical cyclones and other severe weather events in their respective countries in the 2011 hurricane season.

4.2.2 During the Canadian season report, a discussion took place regarding coordination with the French territories of St. Pierre and Miquelon. The Canadian Hurricane Centre had contact information for the weather station for the islands, however efforts needed to continue between Canada and France to increase the comfort with real-time operational information sharing leading up to and during significant weather events.

4.2.3 The Representative of Mexico informed the Committee that the Ministry of Foreign Affairs of Mexico, in the framework of the Tuxtla Mechanism for Dialogue and Coordination, expressed its desire to join efforts with the region of Mesoamerica and the Caribbean to establish a new network of weather radars. Through the recently established Mexican Agency of International Cooperation for Development (AMEXCID) and with a view to strengthening international cooperation among countries for the development of early warning and civil protection measures, Mexico decided to contribute the first radar of the network, which would be donated to Costa Rica. It was expected that, as a result of continuing efforts, a second radar would be established in another country of the region in the near future.

4.2.4 The members' reports submitted to the current session are given in **Appendix IV**.

4.3 Hurricane Hunters

4.3.1 The Committee recognized the indispensable weather data collection efforts of the US Air Force and NOAA hurricane reconnaissance aircraft (call signs: TEAL and NOAA). These tropical cyclone and hurricane flights were key to the international effort to forecast the path and intensity of these potentially devastating cyclones. The data were sent to the NHC/RSMC and to member countries in real time.

4.3.2 In this effort, it was recognized that when the aircraft were granted diplomatic clearance access to each countries sovereign airspace their efforts provided an invaluable benefit for each country and the international community. Unfortunately due to the unpredictable nature of these storms, it was impossible to request, process and receive diplomatic clearance overflight permission in the limited time available for each individual storm. Therefore, each country was strongly encouraged to grant seasonal or permanent blanket overflight clearances to these reconnaissance flights for this effort to save lives and protect property throughout the Region. All reconnaissance flights were conducted according to the International Civil Aviation Organization (ICAO) rules, filed IFR flight plans and maintained constant contact with Air Traffic Control while in flight. In addition, each country's Meteorological Service was aware of all flights through either the Plan of the Day (POD) published on the Web or by direct communication with the National Hurricane Center.

4.3.3 The Committee furthermore recognized the importance of hurricane preparedness and the vital role the CHAT served to meet this requirement. The resources of 53 WRS C-130 "Hurricane Hunter" aircraft and crew in partnership with member nations' weather and emergency management leaders along with the staff from the NHC & NWS were essential in the successful annual public awareness endeavour to save lives and reduce property loss throughout the Caribbean, Mexico and Central America.

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

5.1 Mr Tyrone Sutherland (British Caribbean Territories) agreed to serve as rapporteur on this agenda item. This agenda item allowed Committee members to raise matters that had an impact on the effectiveness of the Hurricane Warning System.

5.2 During the discussions on the 2011 hurricane season, the Committee noted the generally excellent regional coordination of warnings between the RSMC Miami and the respective forecast and warning offices. As happened periodically, the Committee looked at any cases where there were concerns about the actual status of some weather systems as they approached land and the impact on warnings. One example that generated some discussion involved how to deal with a weather system that did not display a closed circulation at the surface (mean sea level), thereby not meeting the definition for classification as a tropical cyclone, but which displayed a clear circulation on radar imagery at a short distance above mean sea level that could actually impact higher terrain. The Committee reiterated the fact that each national warning office had the ability and responsibility to use appropriate language in its warnings to reflect the expected conditions without violating the classification of the system. The Meeting was presented with proposals being developed by the RSMC to deal with warnings for similar cases and cases in which systems that had not yet been classified as a tropical cyclone, but were forecasted to reach such status in the near future. RSMC Miami would conduct in-house experiments during the 2012 hurricane season that would address the possibility of issuing forecasts for pre-tropical cyclone disturbances and tropical cyclone watches and warnings before formation. The RSMC would brief the Committee on the outcome of these experiments at the thirty-fifth session in 2013.

5.3 The Meeting recalled that, at its thirty-third session (Cayman Islands, March 2011), it carried out a review of the backup arrangements for warning responsibilities in its Hurricane Operational Plan, as a result of a request from the British Caribbean Territories on behalf of the Caribbean Meteorological Organization (CMO). In the process of its deliberation on the matter, the Hurricane Committee recognized that there were no backup arrangements for Belize and some other States. The thirty-third session of the Committee came up with the following proposal for modification of the backup arrangements, but indicated that they would need to be decided upon formally on a bilateral basis:

- (i) Antigua would take over the responsibility of Barbados with respect to the island and coastal waters of Dominica;
- (ii) Barbados would take over the responsibility of Antigua and/or Saint Lucia;
- (iii) Barbados would take over the responsibility of Trinidad and Tobago;
- (iv) Jamaica would take over the responsibility of the Cayman Islands;
- (v) Trinidad and Tobago would take over the responsibility of Barbados with respect to the islands and coastal waters of Barbados and St. Vincent and the Grenadines. Trinidad and Tobago would serve as a secondary backup to Barbados with respect to Saint Lucia;
- (vi) The USA would take over the responsibility of Jamaica;
- (vii) The Cayman Islands would take over the responsibility of Belize, with Jamaica serving as a secondary backup to the Cayman Islands with respect to Belize.

5.4 Within Member States of the CMO, formalities for bilateral arrangements were made by the Ministerial-level Caribbean Meteorological Council (CMC), which was the Governing Body of the CMO. The proposals of the thirty-third session of the Hurricane Committee were discussed and accepted by the 51st session of the CMC (Roseau, Dominica, November 2011), which passed a new formal Resolution putting the arrangements into effect for the States shown above. The Hurricane Committee accepted the CMC request to modify Chapter 2 of the Operational Plan to include these formal backup arrangements shown in paragraph 5.3 above, along with any other modifications of backup arrangements for other regional States. At the same time, the Committee reemphasized its earlier suggestion that States with more than one operational office might also consider the ability to transfer forecast and warning operations to those offices as a first measure to try to maintain national responsibilities as much as possible.

6. REVIEW OF THE RA IV HURRICANE OPERATIONAL PLAN

6.1 Under this agenda item, the Committee designated Dr Mark Guishard (Bermuda; English-speaking Vice-chairman) and Dr José Rubiera Torres (Cuba; Spanish-speaking Vice-chairman) to serve as rapporteurs. Mr John Parker (Canada) agreed to serve as a coordinator for Attachment 8A (List of Telephone Numbers of National Meteorological Services and Key Officials) to the RA IV Hurricane Operational Plan.

6.2 The Committee reviewed in depth the Operational Plan, taking into account changes and additions that came out from this and the other agenda items.

6.3 Consideration was given to the inclusion of “monsoon trough” in the Attachment 1 A – Glossary of Storm-Related Terms in Chapter 1. The Committee noted that the term had a specific meaning and was currently being deliberated over at RSMC Miami. It was agreed that this term should be added to the Glossary as necessary, once a consensus was reached at RSMC Miami on the use of the term. The discussion centred around the ongoing debate regarding the similarities between the “monsoon trough” and the “intertropical convergence zone (ITCZ)”, and the consensus was that the term “monsoon trough” should not be used until this debate concluded.

6.4 In Chapter 2, the Committee identified the need for a clear definition of the status of Aruba, which joined this session as an observer, in order to adequately carry out operational arrangement in the Region. In this respect, the Committee recognized that clarification of the Permanent Representative of the Netherlands with WMO was essential. It therefore urged the WMO Secretariat to review the status of Aruba and inform the Committee of the outcome. Meanwhile, the Committee encouraged Aruba to clarify their role and responsibilities at the next session of the Committee.

6.5 The Committee requested the WMO Secretariat to update the figures in Chapter 2 to reflect the changes in name to the jurisdictions formerly known as the Netherlands Antilles and Aruba and also the figures in Chapter 4 according to the proposed changes to the list of coastal radars including addition of those of El Salvador.

6.6 Update of Chapter 5 (Satellite Surveillance) was proposed by the WMO Secretariat (Space Programme) and adopted. Major updates were related to the activation of GOES-15 to replace GOES-11 in December 2011 and the change in polar-orbiting satellites including the launch of Suomi National Polar-orbiting Partnership (NPP) in October 2011.

6.7 RSMC Miami advised the Committee not to update the Vortex Message content in the Attachment 6A as this had not been approved within the USA yet.

6.8 In Chapter 9, the Committee considered retirement of the names of tropical cyclones of significant strength or impact during the previous season. From the Atlantic list, the name 'Irene' was proposed to be retired by the USA and accepted by the Committee. In replacement of 'Irene', the Committee adopted 'Irma', which was to be used for the 2017 season.

6.9 The Committee urged the WMO Secretariat to ensure that above amendments and changes as well as other minor changes made to the Plan were posted to the WMO/TCP Website, both in English and Spanish, before commencement of the 2012 hurricane season. In this connection, the Committee commended Météo-France for its continued update of the Operational Plan in French and its provision to the Meteorological Service of Haiti. The Committee requested the WMO Secretariat to assist Météo-France with this translation.

7. REVIEW OF THE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2011 AND BEYOND

7.0.1 The Committee designated Dr Mark Guishard (Vice-chairman of English-speaking members) and Dr José Rubiera Torres (Vice-chairman of Spanish-speaking members) to serve as rapporteurs.

7.0.2 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 thirty-first session of the Committee.

7.0.3 Regarding the item 1.2.3 "Ships' weather reports", the Committee requested the WMO Secretariat to review the currently planned tasks and update the status and functioning of the Voluntary Observing Ship Scheme as appropriate for implementation of the Committee's programmes on this subject in an adequate manner.

7.0.4 In response to the request of RSMC Miami, members updated the status on the availability of data from the numerous automatic weather stations listed as being installed in the Implementation Plan.

7.0.5 The Committee recommended the President of RA IV to approve the updated RA IV Hurricane Committee's Technical Plan and its Implementation Programme, which is given in **Appendix V**.

7.0.6 The Committee discussed infrequent updates to the Technical Plan and its Implementation Programme in the intersessional period. The general consensus was that the editing of this document could be facilitated on a more regular basis, with assistance from the Regional Office and the WMO Secretariat, which would allow the Committee to give more time to the discussion on decision-making matters during the sessions.

7.1 Meteorological Component

Regional Basic Synoptic Network

7.1.1 The Committee was informed that the Regional Basic Synoptic Network (RBSN) in the Region as of the end of 2011 consisted of 694 stations (218 were automatic weather stations (AWSs)) inclusive of 27 automatic marine stations, which was almost unchanged from the 2010 status except the decrease of surface stations from 538 to 534 in total. The overall status of observations implemented by the RBSN stations continued to remain stable at over 90% for surface observations and 95% for upper-air observations. According to the integrated WWW monitoring (IWM) carried out on a quarterly basis during 2010/2011, the availability of SYNOP reports on the Main Telecommunication Network (MTN) increased to 82% as compared to 80% in 2009/2010, while the TEMP reports remained unchanged as in the previous year at 89%.

Space-Based Observing System

7.1.2 The Committee noted that the Space-Based Observing System (SBOS) had been steadily maintained with the constellations of operational geostationary and polar-orbiting meteorological satellites including GOES-12, GOES-13, GOES-15, and NOAA-19 operated by the United States. To be launched in 2012 were Metop-B and Meteosat-10 by EUMETSAT and the geostationary INSAT-3D by India. As for the R&D satellites, missions were also planned for launch in 2012 with the ISRO-CNES SARAL (with an altimeter) and JAXA's GCOM-W1 (with microwave imager providing all-weather sea surface temperature measurements). Regarding the Global Precipitation Measurement (GPM) programme, launch of its core satellite was now planned for early 2014. An inventory of satellite and instrument characteristics was maintained in the Dossier on the Space-based GOS, available online for download (http://www.wmo.int/pages/prog/sat/gos-dossier_en.php), which provided the gap analyses for the different components of the GOS.

7.1.3 Data accessibility issues were reviewed in the context of the Integrated Global Dissemination Service (IGDDS) project. One objective of this project was to implement a quasi-global coverage of WMO Regions by multipurpose telecommunications satellite-based broadcasting services using the Digital Video Broadcast (DVB) standard. Satellite data access requirements were kept under review at the regional level; the requirements identified by the RA III/RA IV Satellite Data Requirements Task Team were published online: http://satelite.cptec.inpe.br/geonetcast/es/datareq.html .

<u>WMO Information System (WIS/GTS)</u>

7.1.4 The Committee noted that, in RA IV, the International Satellite Communication System (ISCS) would cease at the end of June 2012, and all RA IV users would need to migrate to an Internet FTP solution prior to this date. All Aviation users were to transition to the US FAA World Area Forecast System (WAFS) Internet File Service (WIFS) to continue to receive the WAFS/OPMET data contained on the ISCS broadcast; while all Hydro-Meteorological Offices were to transition to the NWS Global Telecommunication System (GTS) Internet File Service (GIFS) to receive all ISCS transmission products - including the WAFS/OPMET products, other global products and RA IV regional products.

7.1.5 The NOAAnet (OPSnet) Multi-Protocol Label Switching (MPLS) circuits would be replaced by the Regional Telecommunication Hub (RTH) Washington with a Secure Socket Layer Virtual Private Network (SSL VPN) service over the public Internet. Telecommunication interfaces were being developed and deployed by WAFS workstation vendors. The NWS was in the process of making an SSL VPN interface solution available upon request, for local implementation on non-WAFS workstation platforms. Those members needing higher assurance of availability should contact the US NWS, and would have to purchase suitable private line connections to the NOAAnet hub in New York in FY13.

7.1.6 The GEONETCast Americas (GNC-A) pilot project, as a start-up for the full implementation of the ISCS broadcast over the GNC-A service, would not take place in August 2012 due funding shortfalls. The ISCS broadcast over GNC-A was expected to be available in FY13, provided adequate funding was available for the services at the US NWS. Alternate RTH dissemination services were available to RA IV members. These included the "Alert" and "WMO-WMC Washington" sub-channels on the GNC-A, and the Emergency Managers Weather

Information Network (EMWIN) satellite broadcast. GNC-A and EMWIN users would need to purchase the appropriate equipment themselves.

7.1.7 The Committee expressed its concern and interest in that all WMO Member countries in the Region had equal access to the GTS. The Committee strongly encouraged the relevant national authorities and the RTH to provide solutions, both in the short term and long term, to any problems that may impede any Member country in the Region, such as Cuba, to have sufficient access to the GTS.

7.2 Hydrological Component

7.2.1 The regional hydrological advisers worked on reviewing and updating the hydrological component of the Hurricane Committee's Technical Plan. Furthermore, the National Hydrological Services (NHS) continued to work on five topics of national and regional interest: (a) training and continuing education; (b) hydrological warning systems; (c) integrated water resources management; (d) the Carib-HYCOS project; (e) the definition of training needs in the field of hydrology and water resources; and (f) the impact of climate change on water resources.

7.2.2 Regarding the hydrological component of the Hurricane Committee's Technical Plan, the RA IV Hydrological Adviser maintained contacts with Regional Hydrological Advisers, and as a result:

① The hydrological component of the Hurricane Committee's Technical Plan was updated, with the active participation of NHSs;
② A proposal was being prepared for monitoring the hydrological component of the Hurricane Committee's Technical Plan;
③ Coordination was increased between the National Meteorological and Hydrological Services, in all their activities;
④ The system for the communication and transfer of hydrological data between NHSs during severe weather events was strengthened; and
⑤ The hydrological information and data in the hurricane season report was improved.

7.2.3 Moreover, as a result of a regional consultation with countries, with the aim of presenting the results to the Advisory Working Group of the Commission for Hydrology (Geneva, December 2011), the following themes and priorities identified by countries were of interest to the Hurricane Committee:

Quality Management Framework – Hydrology (QMF–Hydrology):

(a) Encourage and assist the NHS to collect data using recognized standardized methods to perform best-available quality management procedures:
(b) Work to share and adapt science and software advances in a similar open architecture manner for a Quality Management Framework or Hydrologic Forecasting and Prediction;
(c) To assist with training NHSs to acquire and implement QMS.

Hydrological Forecasting and Prediction:

(d) Observing, detecting, modelling and forecasting hazards, and communicating forecasts and warnings to the action agencies responsible for responding to disasters to reduce loss of life and property.

Water, Climate and Risk Management:

(e) Encompasses an array of activities associated with hydro-climatology and hydrologic hazard;

(f) Preparation of guidance material for using regional climate model output in water resources assessment and management, seasonal streamflow forecasting, climate requirement of water managers, long-term planning and design, drought forecasting and design flood frequency estimation for operations activities related to high-resolution hydrologic modelling;
(g) Distributing, rapidly and reliably, understandable warnings to authorities, risk managers and the population at risk, with levels of warning that are linked to levels of preparedness, readiness and emergency operations.

Other priority topics or issues (national, regional, or international):

(h) To strengthen regional capacity to effectively manage the hydrological forecast; based in the evaluation of the application of the Regional Flash Flood Guidance System in Central American countries and the Carib-HYCOS in the Caribbean;
(i) Coordinate with WMO Regional Training Centers in surveying Members' training needs in hydrology, and facilitate both the adaptation of existing courses and development of new training courses in hydrology;
(j) To recognize regional needs and gaps in Hydrology;
(k) Hydrological downscaling and scenario generation for Climate Change Adaptation tools for Hydrology;
(l) Priority order, (national or regional) capacity building requirements;
(m) To cooperate in the development of distance learning courses and the use of the Internet for training in the field of hydrology and water resources at different levels (hydrologists and hydrological technicians).

7.2.4 After considering the information presented by the Regional Hydrological Adviser, the Committee recognized the importance of maintaining a coordination mechanism for the hydrological component of the Hurricane Committee's Technical Plan and:

① Invited the Hydrological Adviser to step up measures to improve coordination between NHMSs;
② Invited member countries to keep the hydrological component of the Hurricane Committee's Technical Plan under constant review;
③ Reiterated the importance of the Hydrological Adviser's attendance at the meeting of the Committee.

7.3 Disaster Prevention and Preparedness Component

7.3.1 The Committee noted that following nearly two years of regional and national consultations engaging a number of partners and stakeholders, a detailed report of the institutional and technical capacities and needs of the Caribbean region to support risk assessment and Multi-hazard Early Warning Systems (MHEWS) would be issued shortly. This report highlighted the need for a more coordinated approach to strengthen institutional capacities at national and regional levels to support risk assessment and MHEWS for meteorological, hydrological and climate-related hazards in the Caribbean. More specifically, it would focus on strengthening cooperation within a multi-sectoral, multi-hazard, multi-level approach in the countries/territories in the Region, to ensure that:

(a) Legal and institutional arrangements supporting disaster risk reduction (DRR) and MHEWS were well established;
(b) Risk assessment capacities were developed and applied multi-sectorally for planning and decision-making;
(c) Quality management systems and standard operating procedures (SOPs) were developed between NMHS and other relevant stakeholders to ensure effective execution of MHEWS;

(d) Operational meteorological, hydrological and climate services to support DRR were strengthened at national and regional levels with consideration of user needs and requirements within various sectors;

(e) MHEWS at the national and regional levels were better coordinated and further strengthened to include other high priority hazards.

7.3.2 To achieve these objectives, it was recommended that, as the next steps, the following issues should be addressed:

(1) The recommendations presented in this Report should be reviewed and prioritized for implementation by the RA IV Management Group. The Management Group should consider grouping the prioritized recommendations such that they could be implemented in a logical manner and targeting for quick successes;

(2) Based on identified priorities an implementation plan should be developed for this initiative defining a series of capacity development projects that could be implemented. This plan should include timelines, milestones and deliverables;

(3) The capacity development projects established should possess national and regional dimensions to address the needs identified. They should build on existing institutional mechanisms, capacities and relevant projects (recently completed or in-progress) in the region;

(4) Annual DRR and climate adaptation regional and national multi-stakeholder forums (engaging technical and scientific as well as management networks) needed to be established given the important connections between climate and disaster risk management (DRM) issues. These needed to be linked to existing events and platforms (the RA IV Hurricane Committee, the Caribbean Disaster Emergency Management Agency– Comprehensive Disaster Management (CDEMA–CDM) forum, and the like) to achieve a more coordinated approach to the implementation, planning, progress monitoring and evaluation, and resource mobilization of this initiative;

(5) A resource mobilization strategy should be developed with a view to longer-term development. The sustainability of the Caribbean region needed to be considered in terms of the requirements of capacity development, based on recommendations in this Report and prioritized by the RA IV Management Group, and building on a more coordinated approach engaging internal (e.g. government budgeting and cost recovery models) and external (e.g. donors and development banks) funding sources. This would be achieved as part of the cross-programme resource mobilization strategy of WMO with other partners, as stressed during the Sixteenth World Meteorological Congress;

(6) Specific needs for strengthening the monitoring and forecasting of all priority hazards in the region should be addressed through a strong regional cooperation framework, and demonstrated through the development of concrete projects for strengthening risk assessment and MHEWS in the Caribbean, in coordination and cooperation with end-users such as the DRM agencies.

7.3.3 A preliminary phase I project concept was identified during the last stage of the consultations. This project was to include two components:

Component 1: Governance and institutional frameworks for risk assessment and MHEWS at national level

Facilitate dialogues on national policy/legislation, and workshops in the field of risk management for the strengthening of meteorological, hydrological and climate-related services. Identify the roles and responsibilities of NMSs as reflected in national policy, legal frameworks and institutional coordination mechanisms, within a DRM framework (in partnership with CDEMA, the Organization of American States (OAS) and other partners engaged in this area, including non-members of these organizations, such as the Dutch Caribbean countries).

Component 2: Operational MHEWS capacity development with national and regional components

Develop and demonstrate operational capacities in MHEWS for severe weather (heavy precipitation) and flooding (flash floods and coastal inundation). These capacities must span all components of regional cooperation in national MHEWS, including monitoring and forecasting, risk analysis, dissemination and communication, development or strengthening of SOPs for emergency contingency planning, and activation of emergency plans based on warnings issued on the levels of risks. The design of the phase I proposal should be carried out with consideration for a number of factors.

Develop a concrete proposal, fund raising strategy and implementation plan to address gaps and needs identified as stated in the final Report, in 2012, in cooperation with the WMO RA IV Management Group, RA IV DRR task team for the Caribbean, WMO Members and regional and international partners.

7.4 Training Component

7.4.1 Under this agenda item, the Committee requested Ms Kathy-Ann Caesar (CIMH) to serve as a rapporteur.

7.4.2 The Committee recognized the training events and workshops which were organized in 2011 for the benefit of its members as per below. Since its last session, the Committee had benefited from WMO's education and training activities through the provision of fellowships, attachments, relevant training courses, workshops, seminars, and the provision of advice and assistance to Members.

- Storm Surge Workshop for RA IV Hurricane Committee members, Santo Domingo, Dominican Republic, 21 – 25 February 2011;
- RA IV Workshop on Hurricane Forecasting and Warning and Public Weather Services, Miami, Florida, USA, 21 March – 1 April 2011;
- International Workshop on Satellite Analysis of Tropical Cyclones (IWSATC), Honolulu, Hawaii, USA, 13 to 16 April 2011.

7.4.3 The Committee noted the available training resources produced by COMET. The members were encouraged to make maximum benefit of the available training resources in English and Spanish languages, especially the online Tropical Textbook – a comprehensive guide to understanding tropical weather.

7.4.4 The Committee appreciated that WMO fellowships for long-term and short-term training continued to be granted to the member countries of the Committee under the various WMO programmes. More information on WMO Fellowship programme was available on the Education and Training Programme (ETRP) Website (http://www.wmo.int/pages/prog/dra/etrp/fellowships/fellowsintouch.php).

7.4.5 The Committee noted that the WMO RTCs and national training institutions offered training courses time-to-time and they were made available on ERTP Website.

7.4.6 The training activities offered by the members were extremely valuable. The Committee was encouraged to develop a region wide training needs analysis based around operational hurricane forecast and service competencies as proposed in the previous session. Therefore the Committee members were encouraged to advise WMO of their activities for reporting and planning purposes.

7.4.7 The Committee noted with satisfaction that five meteorologists from Haïti National Meteorological Centre (NMC) had received full training from September 2010 to end of 2011 thanks to WMO and Météo-France funding and support. Each of them would then be able to work as a forecaster with methodology and expertise, using tools like Synergie and MétéoFactory (integrated workstations).

7.4.8 The Committee welcomed the discussions initiated between CIMH and NOAA to begin identifying what were the training needs of the regional members and how NOAA and NHC could assist in developing training strategy. CIMH had the full support of WMO in the developing of training material for the Region. One such collaboration was the development of the AeroCPD (online) course in conjunction with COMET. The online format was used to facilitate more forecasters participation and because it was an economical option.

7.4.9 The Committee recognized that CIMH was working closely with COMET in the development of training modules for the Region. The modules which were developed were in the areas of aviation meteorology, and radar interpretation. However further modules would be developed especially in the area of satellite meteorology. CIMH and COMET were planning to produce an online degree course in the area of synoptic tropical meteorology in the future.

7.4.10 The Committee noted with pleasure that Bermuda had entered into a collaboration with Spain in the area of training of forecasters in operational tropical matters. This had started with one of the forecasters taking part in the recent RA IV Workshop on Hurricane Forecasting and Warning, and Public Weather Forecast, Miami, USA, 12- 23 March 2012. The forecaster was based at the Bermuda Weather Service. In exchange the forecaster was conducting research on behalf of Bermuda.

7.4.11 In connection with the training need for radar interpretation as requested by some members, CIMH informed the Committee that it had and would continue to offer radar training in its Continuing Professional Development program. Radar interpretation was the longest and most comprehensive of the unit of study in the AeroCPD.

7.5 Research Component

7.5.1 The Committee noted that the International Workshop on Rapid Change of Tropical Cyclone Intensity and Movement was successfully held in Xiamen, China from 18-20 October 2011. The workshop highlighted recent advances in the theory and practice of forecasting rapid changes in tropical cyclone intensity and track. Also, the 3-day training session on Tropical Cyclone Ensemble Forecast was successfully conducted from 14-16 December 2011 at the WMO Regional Training Centre in Nanjing, China. It was part of the 2-week International Training Course on Tropical Cyclones (5-16 December 2011). The training course was co-sponsored by the China Meteorological Administration (CMA), WMO/ESCAP Typhoon Committee, WMO World Weather Research Programme (WWRP including THORPEX) and the TCP. The course was especially organized for forecasters of Typhoon Committee member countries on the use of up-to-date ensemble data in tropical cyclone forecasting with focus on maximum wind speeds, rainfall, and landfall timing and location.

7.5.2 The Committee noted that three organized projects on tropical cyclones were currently underway, namely:

a) North Western Pacific Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP) for Typhoon Committee members (Lead: Japan Meteorological Agency (JMA))
b) Typhoon Landfall Forecast Demonstration Project (TLFDP) (Lead: Eastern China Regional Meteorological Centre/CMA))
c) Severe Weather Forecast Demonstration Project (SWFDP) for Southeast Asia (2012-2013; Lead: Regional Forecasting Support Centre Ha Noi)

7.5.3 The Website for the NWP-TCEFP, maintained by the Meteorological Research Institute (MRI) of JMA, had recently been improved based on feedback received from members of the Typhoon Committee. The project was a collaborative effort between WMO and the Typhoon Committee and aimed to explore the utility of ensemble forecast products through THORPEX interactive Grand Global Ensemble (TIGGE) and thus promoted application of the products to the operational forecasting of tropical cyclones. It was closely linked with the TLFDP.

7.5.4 The Website for the TLFDP, which was hosted by the Shanghai Typhoon Institute of the Shanghai Meteorological Bureau, was now online and could also be accessed through the WWRP tropical cyclone Website. TLFDP was a collaborative effort with the NWP-TCEFP. Endorsed by WWRP, TCP and PWS, the TLFDP was a complement of the Shanghai MHEWS project to collect, integrate and display real-time or near real-time forecast results for both landfalling and non-landfalling typhoons, including their track, intensity, wind and rain distribution. The FDP also aimed to develop and integrate techniques to evaluate and assess the accuracy of forecast of time and location of landfall, gale distribution, and torrential rain. It also calculated forecast errors of various systems and made a comprehensive analysis of forecast performance, evaluated the reliability of the forecasts and finally assessed the social and economic impacts of an improved tropical cyclone forecast service.

7.5.5 The Working Group on Tropical Meteorology Research (WGTMR) Expert Team on Climate Change Impacts on Tropical Cyclones organized the Second International Conference on Indian Ocean Tropical Cyclones and Climate Change (New Delhi, India, 14-17 February 2012). The broad thematic areas of the conference included: current status of the operational tropical cyclone forecasting and warning system, progress on the understanding of tropical cyclone genesis, climate change and tropical cyclone activity, tropical cyclone risk and vulnerability assessment and tropical cyclone disaster preparedness, management and reduction.

7.5.6 WWRP in collaboration with the TCP was organizing an International Workshop on Unusual Tropical Cyclone Behaviour tentatively to be held in Guangzhou, China in November 2012. The overarching objective of the workshop would be focused on unusual if not rare tropical cyclone behaviour, especially on motion, evolution, intensity, precipitation patterns and other structure issues. A better understanding of tropical cyclone behaviour led to more accurate forecasts and better guidance for risk managers, both aspects critical to mitigate the adverse impacts of these storms.

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

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 thirty-third session and considered the plan for future action.

8.2 The Committee expressed its satisfaction that WMO, through the Development and Regional Activities Department (DRA) with the support of the WMO Office for North America, Central America and the Caribbean (NCAC), had continued the development of technical cooperation activities to ensure cost-effective services to Members. The NCAC Office had also provided support to regional activities and assisted in the implementation of WMO Programmes in the Region.

Regional activities

8.3 The Committee was informed that:

- During 2011 WMO had continued its Project Office in Mexico to support the National Water Commission in achieving integrated, sustainable management of water and the PREMIA project aimed to, as outlined in the agreement between the WMO and the Government of Mexico, the 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 would be also another area to be covered.

- Based on the Strategic Development Plan 2010-2019 formulated by WMO for the NMS of Mexico in 2010, the Government of Mexico requested of World Bank the formulation of a project to continue the implementation of the Strategic Development Plan for the NMS in the next Mexican Administration (2012-2018). The Modernization Project for the NMS began its formulation in 2011 and the signature had been scheduled in April 2012. The Modernization Project for the NMS of Mexico (USD 105 million) to be funded by the World Bank (2012-2018) included the following four components: 1) Strengthening of institutional capacity; 2) Modernization of the meteorological network; 3) Improvement of meteorology and climate forecasting; and 4) Developing regional capacity with the establishment of regional hydrometeorological centres.

- WMO through its Project Office in Mexico would continue providing support to this project for the Modernization of the NMS of Mexico as well as to the PREMIA project on integrated water management, both projects under the Agreement of Cooperation between WMO and the Government of Mexico.

- The Meeting of NMS's Directors of Iberoamerican Countries was held in Brasilia, Brazil, in November 2011 with the attendance of the Spanish-speaking members of the RA III and RA IV. The Action Plan for the period 2011-2013 was ratified. The main lines of action of the three-year Plan included institutional strengthening of NMHS and resource mobilization; development of climate services through pilot projects; education and training; and development of subregional virtual centres for the mitigation and monitoring of extreme events.

- The RAMSDIS System that provided, in real time, high-resolution satellite imagery and products to Central American countries, continued its execution with great success. The system was expected to be upgraded sometime during 2011. The System was supported by the Government of the United States, Costa Rica's Institute of Meteorology and the Universidad de Costa Rica, assisted by the WMO.

Training

8.4 The Committee was also informed that:

- Focus Group of WMO's Virtual Laboratory on Satellite Meteorology, using Internet and VISITView software, had continued with great success. Discussion took place 3 or 4 times a month and an every other day presence under the threat of a hurricane. These discussions also kept in closely monitoring of the evolution of the El Niño-Southern Oscillation (ENSO). The group was led by NOAA, US NWS at COMET, Barbados and Costa Rica RTCs and Colorado State University.

- WMO, through the trust fund from Spain, supported during 2011 several activities including courses on automatic weather stations maintenance, data processing, climate change, administration of meteorological and hydrological services, flood management, seasonal forecast, hydrology, statistic forecast tools, use of forecast products and satellites, and other topics. Additionally, a series of seminars and workshops were also supported especially in hydrological forecast, seasonal forecast, coastal flooding, and telecommunications interaction.

- The WMO DRR Programmeheld the workshop Strengthening Regional Cooperation to Support Forecasting with Multi-Hazard Approach in RA IV in Cayman Islands in March 2011 and the Special Session on Disaster Risk Reduction and Early Warning Dissemination and Communication Issues in Central America and the Caribbean in Miami in April 2011. These Workshops were cosponsored by different local, regional and international agencies and representatives of most of the RA IV NMHSs and national civil agencies attended the workshops.

- The Master Degree Programme in Hydrology with strong distance and computed aided learning components had continued with great success at the WMO/RTC of Costa Rica, with the participation of students from RA IV countries.

Assistance to NMHS

8.5 The Committee took note that:

- The Central American Project on Multi-Hazard Early Warning System to develop an end-to-end early warning system for Central America, financed by the World Bank and executed by WMO, was currently being implemented in Costa Rica and was expected to finish in 2013.

- The WMO Haiti Task Team continued coordinating the different actions and efforts for the development of the Haiti NMHS. Immediate assistance in 2011 included the donation of seven automatic weather stations from the WMO VCP Programme, two of which have been installed; five fellowships of 12 months were concluded in Toulouse and Martinique (France) supported by WMO and Météo-France. Further, the USA provided two EMWIN systems and training (installation still pending).

- The WMO was also seeking support for a medium-term project proposal to support the development of the NMHS of Haiti, formulated using the findings and recommendations from the WMO assessment mission carried out in Haiti in April 2010.

- The Committee recommended that three to five slots be reserved for Haitian forecasters in the 2013 PWS workshop RSMC Miami, pending the availability of WMO funding for French interpretation. The selection process was to be carried out by Météo-France and agreed by the Director of Haiti NMC. The Committee acknowledged that such decision would reduce the number of slots available to other member countries.

- The Committee recommended that Météo-France provided RSMC Miami with the contact information (mobile numbers and email addresses) of the Permanent Representative of Haiti with WMO, Mr. Yvelt Chery, the Director of the Meteorological Service, Mr. Ronald Semelfort, and the seven forecasters. This information would allow for better coordination between RSMC Miami and Haiti NMC during the hurricane season. It was suggested that the WMO TCP looked into formalising a communication channel through Météo-France or Environment Canada in cases where direct communication between RSMC Miami and Haiti NMC proved to be difficult.

- The Committee thanked Météo-France and Environment Canada for their continued support to Haiti NMC and recommended that such support continued through the 2012 hurricane season and be considered for the 2013 hurricane season.

- It has been agreed that a solution should be sought to provide Haiti NMC with operational workstations for expertise, production and dissemination, possibly the same that Haitian forecasters have been trained on.

- The Committee recommended WMO to organize a high-level visit to Haiti to discuss with Ministers, Haiti NMC and the National Service of Water Resources (SNRE) organization, management and representation issues within WMO.

- The Committee members finally recognized the difficulties "on the ground" in trying to set up a Met service after the 2010 earthquake. It was suggested that an expert within the Region or WMO be sent to Haiti on a regular basis to ensure the follow-up of all the tasks and actions and to advise the Director of Haiti NMC.

VCP projects

8.6 During 2011, the WMO VCP programme received in total one request from the Region from one country. The requesting country was Suriname for transformation from WAFS-Satellite to WAFS-Internet Reception.

9. OTHER MATTERS

Tsunami Early Warning System for the Caribbean

9.1 Dr Mark Guishard reported the Committee that the Intergovernmental Coordination Group for the Caribbean and Adjacent Regions (ICG-CARIBE EWS) recommended, at its 7th meeting (ICG/CARIBE EWS VII) held in Curaçao from 2 to 4 April 2012, to rename the group to Caribbean and Western Atlantic to reflect the present coverage and to include other parts of the Western Atlantic (e.g. Greenland, Argentina and Uruguay which were not under any of the Intergovernmental Oceanographic Commission (IOC) Tsunami Warning Systems).

9.2 The Committee noted that the new ICG Chair, Christa Von Hillebrandt, sent regrets that she was unable to attend the thirty-fourth session of the Committee. The Committee recognized and welcomed the representation of ICG on the current session by the representative from Curaçao, Dr Albert Martis. This arrangement was facilitated in light of the short time between the elections of the Executive of the ICG and thirty-fourth session of the Hurricane Committee.

9.3 The Committee also noted that under the guidance of the ICG-CARIBE EWS, the USA continued the establishment of a Caribbean Tsunami Warning Programme at the University of

Puerto Rico-Mayaguez, with a view to developing a Caribbean Tsunami Warning Centre. This was being done in a phased manner. Until a regional warning system was established and operational, the US Pacific Tsunami Warning Center (PTWC) in Hawaii would provide interim tsunami watch services for the region, with the exception of US and Canadian jurisdictions, which were covered by the West Coast and Alaska Tsunami Warning Center (WCATWCA).

9.4 It should be noted that bulletins were issued by the PTWC and the WCATWC as advice to government agencies. Only national and local government agencies had the authority to make decisions regarding the official state of alert in their area and any actions taken in response. As such, members were urged to examine the risk posed to their jurisdictions and assist their governments in the development of the appropriate responses to a tsunami scenario.

9.5 In conjunction with ICG activities, a Region-wide Tsunami Exercise entitled CARIBE WAVE 13 / LANTEX 13 would be held on 20 March 2013. The scenario would be an 8.5 earthquake off the coast of the ABC islands and Venezuela which would generate a tsunami which would impact to different degrees the Caribbean and portions of the Western Atlantic. It was being modelled after the CARIBE WAVE 11 / LANTEX 11 which was conducted on 23 March 2011. Thirty-four Members States participated in this exercise, and the exercise was recognized to be a great success in highlighting the threat of tsunamis to the region, testing communications, and also to reveal areas for improvement within the system, to the goal of reaching through 'the last mile' to those at risk.

9.6 Concern was expressed at the recent ICG/CARIBE EWS VII regarding upcoming changes to the means of communications via the GTS, and interest was expressed in the thirty-fourth session of the Hurricane Committee having some discussions regarding this matter.

9.7 Noting that the next ICG meeting would be held in the latter half of April 2013, with the venue to be confirmed, the Committee requested the WMO Secretariat to take an action to facilitate participation of the representative of the Committee in the meeting, and to ensure that there would be no conflicts with the Hurricane Committee 2013 session.

Emerging issues of telecommunication in RA IV

9.8 The Committee held a side meeting to discuss the recent development of the telecommunication in RA IV, focusing in particular the ISCS transition. It invited Mr Robert Gillespie of NOAA to serve as rapporteur on this subject.

9.9 Mr Gillespie presented ISCS transition in RA IV for coordination and comment. The presentation revisited the plan originally addressed to RA IV member States on the December 16, 2011, in an RTH Washington teleconference call; as well as the more recent official notification sent by the Regional WMO Office on April 2, 2012, to all RA IV users. The ISCS transition is expected to be completed by the end of May 2012, approximately 30 days prior to the end of the ISCS satellite broadcast service on June 30, 2012. With close to 90% of the RA IV end users operating WAFS workstation to send and receive GTS data, all were reminded to contact their respective workstation vendor (GST, IES, Météo-France, and MORCOM/CORBOR) to discuss workstation modification that needed to take place to successfully implement the new telecommunication interfaces.

9.10 The RTH Primary Data Collection service, employing FTP over the ISCS OPSnet MPLS circuits, was being modified by replacing OPSnet circuits with a Secure Socket Layer Virtual Private Network (SSL VPN) protocol service over the public Internet. Both the WAFS workstation vendors and the US NWS had developed and were preparing to implement these new interfaces at RA IV sites. SSL VPN interface implementation activities would commence the week of April

16, 2012. End users had been requested to use the Email Data Input System (EDIS) for the submission of text products in the event the OPSnet connections failed and the SSL VPN interface had not been successfully implemented at their site. After the SSL VPN was successfully installed, EDIS would revert for use as a backup service.

9.11 The RTH Primary Dissemination service, the ISCS satellite broadcast service, was being replaced by two separate services. The US FAA WAFS Internet File Service (WIFS) made all the ISCS WAFS/OPMET aviation weather products available for the aviation community end users to download over the public Internet. WAFS workstation vendors currently offered their users a workstation modification to access and download products from the WIFS. The US NWS was developing a similar file service known as the GTS Internet Files Service (GIFS) to host all the products found on the ISCS satellite broadcast, including WAFS/OPMET data and other global GTS products, and the RA IV regional products intended for distribution only within RA IV. RA IV offices could take advantage of the installed WIFS interface to download products from the GIFS file server. A Web browser graphical interface could also be used to browse and download files from both the WIFS and GIFS file servers. Both WIFS and GIFS required users to have a reliable Internet service, and establish an account on each of the systems to access the data. The WIFS service had been operational since the summer of 2011; GIFS was scheduled to become operational in May 2012. All ISCS users were called upon to complete their transition to the WIFS or GIFS prior to the end of the ISCS satellite broadcast service on June 30, 2012.

9.12 The RTH had identified the GNC-A satellite broadcast service as a backup service for GIFS. The implementation of the ISCS broadcast over GNC-A was to take place in FY13, subject to the availability of funds at the US NWS. WAFS workstation vendors were aware of the implementation of this planned service, which would require the installation and configuration of a new workstation interface in the future.

9.13 Two other notable RTH dissemination services were identified in RA IV. GNC-A was operational in several countries throughout RA IV and currently provided two sub-channels originating from RTH Washington to broadcast a limited number of alert and warning messages. The second system was the EMWIN which broadcast text and graphical products, including tsunami warnings and alerts. RA IV member States interested in modifying the content of the traffic on the either system should coordinate with Mr Glendell DeSouza gde_souza@cmo.org.tt to request changes by RTH Washington.

9.14 A summary schedule of events for the transition was presented in the briefing as follows:

- RTH-Washington Data Collection Service Transition (from OPSnet to SSL VPN)
  - NOW: Contact workstation vendor to discuss your SSL VPN options
  - April 4-12: Sites to verify and exercise EDIS is operational
  - April 10–May 13: SSL VPN Interface installation period
    - a, Workstation vendor software implementation
    - b, US Government V-FIDS interface software implementation
  - April 13: US Disconnect Order for OPSnet circuits submitted
  - April 13–May 13: OPSnet circuit disconnects will occur. If your circuit is disconnected, switch to EDIS.
- RTH-Washington Data Dissemination Service Transition (from ISCS Broadcast to GIFS)
  - NOW: Contact workstation vendor to discuss GIFS/WIFS option
  - April 9-30: GIFS Operational Interface Development and Testing
  - May 1-31: GIFS User Interface Implementation
  - June 30: ISCS Satellite broadcast ends, all sites fully transitioned to GIFS

9.15 The ISCS transition brief was available on the Website of the thirty-fourth session of the Hurricane Committee for download.

9.16 Two concerns were introduced by the members at the conclusion of the presentation:

(a) The ISCS transition was replacing the ISCS satellite broadcast RTH data-push technology with an end user data-pull service. This could be significant in considering the introduction of transmission delay for critical alert and warning messages such as tsunami alerts and warnings. Members were careful to point out the need for individual sites to carefully consider how often the site would need to query GIFS to assure delays were minimized. The thirty-fourth session of the Committee was reminded of the GNC-A and EMWIN systems available to the Region to restore RTH-push services for these critical alert and warning messages.

(b) The transition process had highlighted the need to plan and coordinate WAFS workstation upgrades at all aviation service facilities in RA IV. Many of the current workstations were dated and without service support contracts. The sites recognized the need to upgrade or replace systems, but needed to engage their budget process to plan and set aside funds for this purpose. Other factors would also impact the scope, cost and schedule for making necessary changes. By way of example, the World Area Forecast Center (WAFC) Washington would do away with GRIB-1 forecast products and move completely to GRIB-2 in November 2013. This would require the integration of new applications in the older systems or the replacement of the old systems altogether. A mechanism for identifying, communicating and coordinating new requirements in RA IV which would require modifications to equipment and/or operations needed to be implemented. In the immediate future, an RA IV plan to upgrade or replace existing WAFS workstations needed to be considered and should be elevated to the RA IV Management Committee for consideration.

Procedural matters for the arrangement of the sessions

9.17 In light of the current economic climate, the Committee recognized that it needed to demonstrate (to the RA IV member States and to the WMO Secretariat) a proactive approach to improve efficiency. In addition, partnerships with the private sector and non-governmental organizations would necessarily become more important, given the budgetary constraints. Accordingly, the Secretariat was encouraged to establish some guidelines when it came to arrangements for the sessions, in collaboration with the Committee and host countries.

9.18 There were some sensitive and proprietary items discussed in the meeting that the Committee may not want released to the public in advance of a Final Report being submitted. Hence, the Committee recommended that access to the meeting by non-members or official observers be better controlled (but not necessarily removed outright).

9.19 The Committee recognized the vital role the private sector played in supporting the activities of the Committee, so it was also important that outlets for their contributions were explored. The Committee recommended allocating a portion of the session to allowing discussion with sponsors be facilitated, but not at the expense of the short time available to discuss operational, technical and policy matters. Thus far, private sector partners had respectfully and judiciously used their time allowed in the meetings, and the Committee thanked them for this. However, in this age of instant communications technology, an attempt must be made to exert a measure of control over information flowing from this Committee. This may be achieved by restricting access to the main body of the session.

9.20 The Committee would consider the length and structure of the meeting, with side meetings, tours, field trips, 2-hour lunch breaks and tight deadlines, an increasingly busy agenda would not be sustainable in future.

10. DATE AND PLACE OF THE THIRTY-FIFTH SESSION

The Committee was informed that Curaçao would consider hosting the thirty-fifth session of the RA IV Hurricane Committee in conjunction with the 16th session of RA IV in 2013.

11. CLOSURE OF THE SESSION

The report of the thirty-fourth session of the Committee was adopted at its final meeting at 12.13 hours on 15 April 2012.

LIST OF APPENDICES

APPENDIX I

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Mr Matthew MURRAY **Ms Jennifer BUNTING**	RAYTHEON
Mr Roger LAVALLEE	VALPRO

AGENDA

1. ORGANIZATION OF THE SESSION

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

2. REPORT OF THE CHAIRMAN OF THE COMMITTEE

3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME

4. REVIEW OF THE PAST HURRICANE SEASON

    4.1 Summary of the past season
    4.2 Reports of hurricanes, tropical storms, tropical disturbances and related flooding during 2011
    4.3 Report from Hurricane Hunters

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 2012 AND BEYOND

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

9. OTHER MATTERS

10. DATE AND PLACE OF THE THIRTY-FIFTH SESSION

11. CLOSURE OF THE SESSION

SUMMARY OF THE PAST SEASON

2010 Atlantic and Eastern North Pacific Hurricane Season Summary

(*Submitted by the RSMC Miami*)

Atlantic

The 2011 Atlantic hurricane season was marked by above average tropical cyclone activity with the formation of 19 tropical storms, of which 7 became hurricanes (Figure 1 and Table 1). Four of the hurricanes strengthened into major hurricanes (Category 3 or higher on the Saffir-Simpson Hurricane Wind Scale). The numbers of tropical storms, hurricanes and major hurricanes were each above the long-term average (1981-2010) of 12, 6, and 3 respectively. In terms of the accumulated cyclone energy (ACE) index, 2011 had 137% of the long-term median ACE. Similar to 2010, there was a tendency for a middle-latitude trough to become established along the United States east coast forcing many of the tropical cyclones to turn northward well east of the United States eastern seaboard (Figure 2). Irene was the exception, and was the only hurricane to affect the United States in 2011. Cindy, Franklin, and Jose were short-lived tropical storms that formed in the subtropical Atlantic and moved northeastward over open waters. Their history details are not included here.

Hurricane specialists at the National Hurricane Center were very fortunate to gather NOAA buoy data in real time when several cyclones moved over these buoys. In the individual storm descriptions, all dates and times are based on Universal Coordinate Time (UTC).

For all operationally designated tropical or subtropical cyclones in the Atlantic and eastern North Pacific basins, the National Hurricane Center (NHC) issues an "official" forecast of the cyclone's center location and maximum 1-min surface wind speed. Forecasts are issued every 6 h, and contain projections valid 12, 24, 36, 48, 72, 96, and 120 h after the forecast's nominal initial time (0000, 0600, 1200, or 1800 UTC) At the conclusion of the season, forecasts are evaluated by comparing the projected positions and intensities to the corresponding post-storm derived "best track" positions and intensities for each cyclone. A forecast is included in the verification only if the system is classified in the final best track as a tropical (or subtropical cyclone at both the forecast's initial time and at the projection's valid time. All other stages of development (e.g., tropical wave, [remnant] low, extratropical) are excluded. For verification purposes, forecasts associated with special advisories do not supersede the original forecast issued for that synoptic time; rather, the original forecast is retained. All verifications in this report include the depression stage. The 2011 official forecast errors for the Atlantic and Eastern North Pacific are included in Figures 5 and 8, respectively.

Tropical Storm Arlene

An Air Force Reserve Hurricane Hunter aircraft investigated a low pressure system in the Bay of Campeche on June 28, and measured tropical-storm-force winds. On this basis, it is estimated that a tropical storm formed about 300 miles east-southeast of Tampico, Mexico. Arlene moved west-northwestward and had its maximum sustained winds of 65 mph when the storm made landfall near Cabo Rojo, Mexico at 1300 UTC June 30. Arlene dissipated over the mountains of Central Mexico the next day.

Tamesi, in the state of Tamaulipas, reported 13.73 inches of rain in 24 h, and heavy rains also occurred over extreme southern Texas. Media reports indicate that 18 people died due to direct effects of Arlene. Most of the deaths were due to freshwater floods and mudslides in eastern Mexico.

Tropical Storm Bret

Bret formed from an area of disturbed weather associated with a frontal zone on July 17 about 70 miles north of Grand Bahama Island, and reached its peak intensity of 70 mph on July 18. The cyclone weakened slowly as it moved northeastward, and dissipated on July 23 about 490 mi south-southwest of Cape Race, Newfoundland. There was an unofficial report of a 48-mph wind gust from Abaco Island in the northwestern Bahamas on July 18.

Tropical Storm Don

A tropical wave entered the Caribbean Sea on July23, producing heavy squalls in Puerto Rico and the U. S. Virgin Islands. The wave continued westward and the associated thunderstorm activity became better organized in the northwestern Caribbean Sea. A tropical depression formed early on July 27 about 60 miles northeast of Cancun, Mexico and became a tropical storm later in the day.

Don moved across the Gulf of Mexico, where a relatively dry air mass prevented significant intensification. The cyclone reached50 mph, but Don weakened to a tropical depression when it made landfall in Texas around 0230 UTC 30 July along the Padre Island National Seashore. After landfall, Don quickly dissipated near Alice, Texas. Only light rainfall occurred in Texas.

Tropical Storm Emily

Air Force reconnaissance aircraft data indicate that a tropical storm formed from a vigorous tropical wave on August 2 about 50 miles northwest of Martinique. Emily moved west-northwestward and passed about 200 miles south of Puerto Rico during August 2 and 3. The cyclone moved over Hispaniola on August 4 and degenerated into an open wave. The remnants of Emily moved west-northwestward through the Bahamas and regenerated into a tropical storm on August 6 near Grand Bahamas Island. The cyclone turned northeastward and degenerated into a remnant low on August 7.

Heavy rains and high winds associated with Emily occurred over portions of the Lesser Antilles. The largest rainfall totals in Puerto Rico were generally over the eastern part of the island, with Caguas reporting the largest amount of 8.22 inches (209 mm). A total of 21 inches (528 mm) was reported in Neiba in the Dominican Republic resulting in three direct deaths.

Tropical Storm Harvey

A tropical depression formed on August 19 about 100 miles northeast of Cabo Gracias a Dios on the border of Nicaragua and Honduras. The depression became a tropical storm and moved just to the north of Honduras and the Bay Islands, and then reached a peak intensity of 65mphat landfall near Dangriga, Belize at 1730 UTC August 20. Harvey weakened and moved over the Bay of Campeche on August 21, when it re-intensified slightly. The storm made a second landfall around 0200 UTC on August 22 near Punta Roca Partida, Mexico and then dissipated over high terrain.

High winds and heavy rain were noted in Dangriga during the storm, but there were no reports of damage or casualties there. In Mexico, three people were killed in San Lucas Zoquiapam, Oaxaca during a landslide. Harvey caused significant floods, and 334 homes were damaged in Veracruz.

Hurricane Irene

A reconnaissance aircraft investigated a tropical wave approaching the Lesser Antilles for several hours on 20 August, finding surface winds of 45-50 mph but no well-defined closed low-level circulation. Just before the conclusion of the mission, the aircraft was able to identify a circulation near the southern edge of the convection about 140 miles east of Martinique, marking the formation of a tropical storm early on August 21. Irene moved over St. Croix around 2300 UTC that day, when a period of light winds associated with the center was observed, and in fact an Air

Force Reserve Hurricane Hunter aircraft was able to depart St. Croix for its mission during that period of calm.

Irene became a hurricane while moving over Puerto Rico early on August 22, but the hurricane-force winds remained over water and did not affect the island. Irene became a category 3hurricane with a peak intensity of 120 mph early on August 24, when it was centered between Mayaguana and Grand Inagua in the Bahamas. The hurricane crossed Acklins and Crooked Islands near 1500 UTC August 24, and these islands likely experienced category 3 hurricane conditions. Irene weakened a little bit before moving over Long Island around 0000 UTC August 25.

Irene's eye passed between Exuma and Cat Island around 0600 UTC 25 August, crossed Eleuthera a few hours later, and then reached the Abaco Islands in the northwestern Bahamas around 1800 UTC August 25. By then Irene had weakened further, and these islands probably experienced category 2 hurricane conditions. Irene moved northward and made landfall near Cape Lookout, North Carolina at 1200 UTC August 27 with an intensity of 85 mph, producing category 1 hurricane-force winds within a swath primarily to the east of the center over the North Carolina sounds and the Outer Banks. Irene then continued north-northeastward, just offshore of the Delmarva peninsula, and made another landfall very near Atlantic City, New Jersey, at Brigantine Island, at 0935 UTC 28 August. Although Irene's intensity at the New Jersey landfall was 70 mph, the storm's strongest winds were confined to the waters east of the center. Irene continued moving north-northeastward and the center moved over Coney Island, Brooklyn, New York around 1300 UTC 28 August, and over Manhattan, New York City about 1 hour later. By then the cyclone's strongest winds of65 mph were occurring over water east of the center. Irene moved north-northeastward over the northeastern United States and became extratropical near the New Hampshire/Vermont border early on August 29. The cyclone was absorbed on 30 August over northeastern Canada by a frontal system.

There were unconfirmed reports of wind gusts of 115mph in Moss Town, Exuma and in Arthur's Town on Cat Island around 0600 UTC 25 August. An automatic weather station in Grand Bahama reported sustained winds of 91 mph at 0100 UTC 26 August.

Irene produced copious amounts of rain in Puerto Rico, with a maximum of 22.05 inches in Gurabo Abajo, which caused major flooding in the northeastern portion of the island. In addition, Irene produced a large swath of 5 to 10 inches of rain along the east coast of the United States from North Carolina northward. The maximum rainfall amount observed was 15.74 inches in Bayboro, North Carolina.

Irene was a large hurricane that generated high waves and storm surge over a large portion of the western Atlantic basin for several days. The highest storm surge value reported by a tide gage was 7.09 ft on August 28 at Oregon Inlet Marina, NC. Post storm surveys suggest that a storm surge of 8 to 11 ft occurred within portions of Pamlico Sound. Storm surge values between 4 and 6 ft were measured along the coast from New Jersey northward.

Irene spawned several tornadoes along its path over the eastern United States. The strongest was an EF2 tornado in Columbia, North Carolina, destroying a few manufactured homes.

Preliminary reports indicate that Irene was responsible for 49 direct deaths: 5 in the Dominican Republic, 3 in Haiti, and 41 in the United States. Surprisingly, there were no reported deaths in the Bahamas, where Irene was the strongest. For the United States, 6 deaths are attributed to storm surge/waves, or rip currents, 14 to wind, including from falling trees, and 21 to rainfall-induced floods.

Surge and high waves damaged homes in portions of the north coast of the Dominican Republic. Damage from rains was extensive across Puerto Rico. In the mainland United States, Irene caused widespread damage to homes and felled trees from North Carolina northward, and produced extensive power outages. In North Carolina, the flow from the sound to the ocean damaged Highway 12, cutting several breaches. The most severe surge damage occurred between Oregon Inlet and Cape Hatteras, but significant storm surge damage also occurred along southern Chesapeake Bay. In the Hampton Roads and along coastal sections of the Delmarva Peninsula from Ocean City, Maryland southward, storm surge flooding was comparable to that from Hurricane Isabel of 2003.

Since the strongest winds were over water to the east of Irene's center, New York City escaped severe damage. Nonetheless, a storm surge of 3-6 ft caused hundreds of millions of dollars in property damage in New York City and Long Island. Irene's main impactin the northeastern United States, however, was from rainfall. Catastrophic floods occurred in New York and New England, especially in central and southern Vermont. These rains caused devastating flash flooding across many mountain valleys with some record breaking flood stages on larger rivers.

In the United States, the Insurances Services Office reported that the hurricane caused an estimated $3.5 billion in losses. Doubling this figure, to account for uninsured losses, results in a preliminary U. S. damage estimate of $ 7billion.

Hurricane Katia

A tropical depression formed about 430 miles southwest of the Cape Verde Islands on August 29 and became a tropical storm the next day. Katia moved westward and reached hurricane intensity on September 1 about 1350 miles east of the Leeward Islands. The cyclone began a period of rapid intensification on September 4 and around 1235 UTC that day, the hurricane's eye passed very near NOAA buoy 41044, which recorded a wind gust of 108 mph. Katia reached its peak intensity of 140 mph about 470 n mi south of Bermuda.

The hurricane turned toward the east-northeast and became a powerful extratropical low about 290 miles south-southeast of Cape Race, Newfoundland. The storm moved along the northern coast of Scotland on September 12 bringing hurricane-force wind gusts to much of Scotland, Northern Ireland, and northern England. The extratropical cyclone caused widespread power outages across much of Northern Ireland, northern England, and Scotland due to downed trees and power lines.

Unnamed tropical storm

As part of its routine post-season review, the National Hurricane Center (NHC) occasionally identifies from new data or meteorological interpretation a previously undesignated tropical or subtropical cyclone. The NHC re-analysis of 2011 has concluded that a short-lived low that passed between Bermuda and Nova Scotia from 31 August to 3 September briefly had sufficient tropical characteristics to be considered a tropical storm. This unnamed tropical storm formed on September 1, about 335miles north of Bermuda and moved slowly and erratically. The storm accelerated northeastward on 2 September and became extratropical on September 3 about 355 miles south-southeast of Halifax, Nova Scotia.

Tropical Storm Lee

A tropical depression formed on September 2 about 220 mi southwest of the mouth of the Mississippi River and moved slowly northward, reaching tropical storm status later in the day. Leebegan to take on the appearance of a subtropical cyclone with expanding radius of maximum winds and relatively weak convection near the center and it was then classified as a subtropical storm early on the September 3. Lee reached a maximum intensity of 60 mph on September4 and meandered just off the south-central coast of Louisiana during the next 12-18 h. Lee made landfall around 1030 UTC September 4, along the coast of southern Louisiana, about 10 miles south-southeast of Intracoastal City with maximum winds of 45 mph. After landfall, Lee became nearly stationary over south-central Louisiana and merged with an unusually strong cold front September 5.

Numerous oil platforms over the northern Gulf of Mexico reported tropical-storm-force winds in association with Lee. The highest wind observation was 60 mph at the Mississippi Canyon 802 (42362) platform. The anemometers on these oil rigs are, however, quite elevated. Sustained tropical-storm-force winds were reported near the coasts of Alabama, Mississippi, Louisiana, and extreme eastern Texas during the time Lee was classified as a tropical or subtropical cyclone. The highest 1-min sustained wind report from a land station was 50 mph with a gust to 54 mph at a University of Alabama mesonet site on Dauphin Island, Alabama on September 3.

Strong onshore winds from Lee along the northern Gulf Coast produced elevated water levels from Louisiana eastward to the Florida Panhandle for several days. The highest storm surge reported was 4.67 ft at Amerada Pass, Louisiana. The highest surge in Florida or Alabama was 4.40 ft at a National Ocean Service tide gauge at the Coast Guard station in Mobile Bay.

Rainfall amounts of 10-15 inches were reported over a large area along the northern Gulf Coast from southeastern Louisiana eastward across southern Mississippi and southern Alabama. A large swath of 7-10-inch rains with isolated maximum amounts of 10 to 14 inches also occurred north of the cyclone's center path across south-central Mississippi, northern Alabama, extreme northwestern Georgia, and eastern Tennessee. Moisture from Lee and its remnants spread northeastward along a frontal boundary that became stationary across the Mid-Atlantic States and southern New York. This produced a second area of extremely heavy rainfall from eastern Virginia northward across Maryland, eastern Pennsylvania, New Jersey, southern New York, and portions of southern New England during 5-10 September. Lee and its remnants produced 46 tornadoes, mainly across the southeastern United States.

Lee was responsible for three direct deaths during its time as a (sub) tropical cyclone: two from rough surf and one from inland flooding. Media reports indicate that flooding largely related to the remnants of Lee was responsible for at least 12 additional deaths in the eastern United States; seven people in Pennsylvania, four in Virginia, one in Maryland, and one in Georgia. Nearly all of these deaths occurred when individuals tried to cross flooded roadways in vehicles or were swept away in flood waters. Preliminary damage estimates indicate that Lee produced at least $300 million in insured losses in the U.S. In addition, media reports indicate the flooding from the remnants of Lee produced more than $1 billion in damage in the mid-Atlantic and northeast United States.

Hurricane Maria

A tropical depression formed on September 6 about 800 miles west-southwest of the southern Cape Verde Islands and moved quickly west-northwestward at 15 to 20 mph, reaching tropical storm intensity later in the day. However, the low-level circulation lost definition, and Maria dissipated as a tropical cyclone even though it was still producing sustained winds of 50 mph. The remnants of Maria approached the Lesser Antilles late on 9 September and when a new center developed on September 10 about 45 miles east-southeast of Antigua, Maria again became a tropical storm.

Maria passed to the north of the Virgin Islands and Puerto Rico and reached hurricane intensity on September 15 while centered about 155 miles northwest of Bermuda. Maria accelerated northeastward, weakened, and made landfall around 1830 UTC 16 September near Cape St. Mary's on the Avalon Peninsula of Newfoundland, with maximum winds of 70 mph. The cyclone's circulation was absorbed by a frontal system shortly thereafter.

During 9-11 September, Maria produced sustained winds of50 mph at La Desirade, located just to the east of Guadeloupe. Tropical-storm-force wind gusts were observed on Antigua, Guadeloupe, Marie-Galante, Barbuda, St. Maarten/St. Martin, St. Croix, and St. Thomas. Widespread rainfall totals of 5 to 11 inches were observed in Puerto Rico.

Hurricane Nate

Nate formed from an area of low pressure along the southern end of a frontal system on September 8 about 160 miles north of Villahermosa, Mexico. Although dry air behind the original front slowed the intensification process, Nate reached hurricane strength with 75 mph winds. However, the slow forward motion of the cyclone over the shallow waters of the Bay of Campeche caused significant upwelling resulting in Nate to weaken. The cyclone then moved westward over the central Bay of Campeche as a tropical storm and crossed the coast of northeastern Mexico near Barra de Tecolutla at 1600 UTC September 10. Nate dissipated shortly after landfall.

There were four direct deaths and one indirect death associated with Nate. Ten workers were forced to abandon their lifeboat on 8 September after evacuating the Trinity II oil rig. Seven of the ten men were rescued, but one later died from an unknown cause. The bodies of the three remaining workers were eventually recovered. A nine-year-old child was killed by lightning in Veracruz.

Hurricane Ophelia

A tropical depression formed about 1500 miles east of the Lesser Antilles on 20 September and became a tropical storm as it moved westward over the tropical Atlantic. However, southwesterly wind shear increased and Ophelia degenerated into a remnant low pressure system on September 25 east of the northern Leeward Islands. A surface center redeveloped within the lingering convection and a tropical depression formed about 200 miles east of the northern Leeward Islands on 27 September. Ophelia became a major hurricane on September 30well north of the Leeward Islands and reached its peak intensity of 140 mph on October 2 after passing near Bermuda. The wind field associated with the major hurricane was so compact that winds on Bermuda did not even reach tropical storm force. Ophelia weakened rapidly and lost its tropical characteristics just before it made landfall over southern Newfoundland around 1000 UTC 3 October.

The eye of Ophelia passed directly over NOAA buoy 41049 at 0830 UTC 1 October. The buoy reported a maximum 1-min wind of 97 mph with a gust to 106 mph in the northern eye wall and a minimum pressure of 952.8 mb.

Hurricane Phillippe

A tropical depression formed from a tropical wave on September 24 about 260 miles south of the southernmost Cape Verde Islands and strengthened to a tropical storm later in the day. After a period of weakening, deep convection re-developed near the center and Philippe re-strengthened to a tropical storm later that day. Philippe turned toward the southwest and became a hurricane on October 4 about 545miles northeast of the Leeward Islands. The cyclone weakened again due to wind shear and made a slow but sharp turn toward the northwest and north over the western Atlantic.

The vertical shear abated while Philippe turned northward, and the cyclone intensified one final time, becoming a hurricane about 460miles south-southeast of Bermuda on October 6. The hurricane turned northeastward later that day, and reached its maximum intensity of 90 mph. Philippe began to weaken on October 7 and later became an extratropical cyclone.

Hurricane Rina

A tropical depression formed just off the coast of Nicaragua on October 23, moved very slowly northward and became a tropical storm. Rinathen rapidly intensified over the deep warm waters of the western Caribbean and became a major hurricane, with a peak intensity of 115 mph on October 26about250 mi east-southeast of Chetumal, Mexico. Fortunately, the cyclone weakened before making landfall near Playa del Carmen, with an intensity of 60 mph near 0300

UTC October 28. The next day, the center of Rina emerged into the Yucatan Channel and dissipated near the western tip of Cuba.

Tropical Storm Sean

A frontal low that caused heavy snow in Colorado on November 3 moved off the U.S east coast the next day. A subtropical storm formed from this low on November 8 about 445 miles southwest of Bermuda. Sean moved erratically and quickly made a transition into a tropical storm later that day when the convection became concentrated near the center. It reached its peak intensity of 65 mph on November 10 before Sean turned toward the north-northeast and merged with a cold front.

Table 1 - Atlantic Summary Table

Storm Name	Class*	Dates**	Maximum Winds (mph)	Minimum Central Pressure (mb)	Deaths	U.S. Damage ($million)
Arlene	TS	June 28 –July 1	65	993	18	
Bret	TS	July 17-22	70	995		
Cindy	TS	July 20 -22	70	994		
Don	TS	July 27-30	50	997		
Emily	TS	August 2-7	50	1003	3	
Franklin	TS	August 12-13	45	1004		
Gert	TS	August 13-16	65	1000		
Harvey	TS	August 19-22	65	994		
Irene	MH	August 21-28	120	942	49	7000
Jose	TS	August 27-28	45	1006		
Katia	MH	29 Aug -10 Sep	140	942		
Unnamed	TS	September 1 -2	45	1002		
Lee	Lee	September 2-5	60	986	3	315
Maria	H	September 6-16	80	983		
Nate	H	September7-11	75	994	4	
Ophelia	MH	Sep 20- Oct 3	140	940		
Philippe	H	Sep 24-Oct 8	90	976		
Rina	MH	October 23-28	115	966		
Sean	TS	November 8 -11	65	982		

* TD – tropical depression, maximum sustained winds 38 mph or less; TS – tropical storm, maximum sustained winds 39 – 73 mph; H – hurricane, maximum sustained winds 74 – 110 mph; MH – major hurricane, maximum sustained winds 111 mph or higher.
** Dates based on UTC time and include tropical depression stage.

Note: The Accumulated Cyclone Energy (ACE) index is a measure of the collective strength and duration of all tropical storms and hurricanes during the year, calculated by adding up the squares of the maximum wind speeds (in knots) at six-hour intervals for each storm.

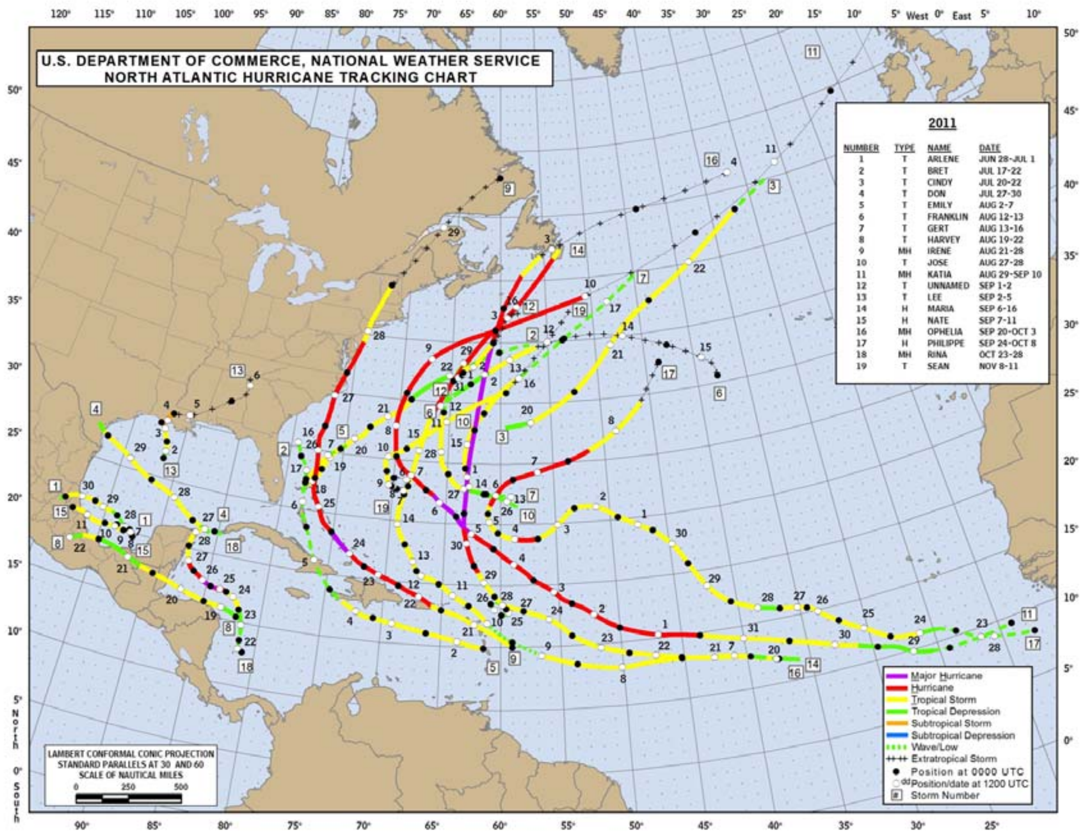

Fig. 1 -Tracks of Atlantic tropical storms and hurricane during 2011.

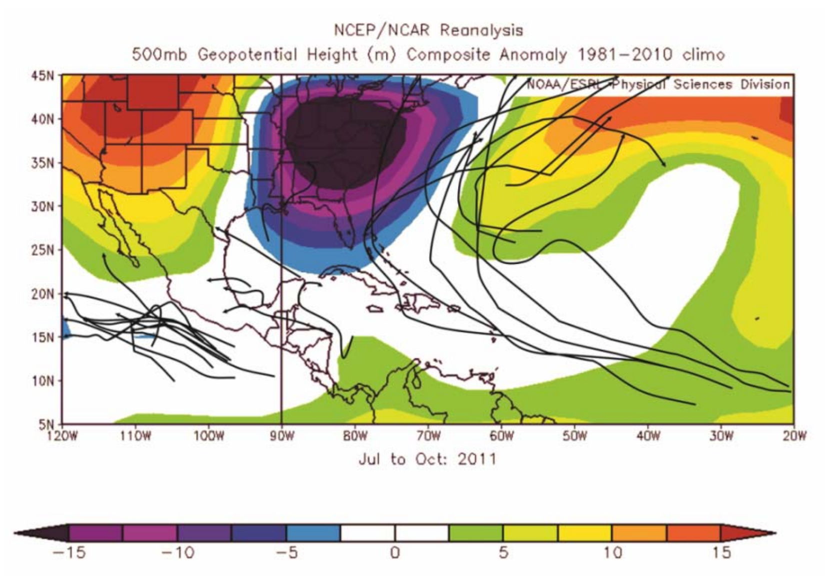

Fig. 2 – 500 mbgeopotential height anomalies from July to October 2011. Note the area of below average heights (purple) over the eastern United Sates seaboard.

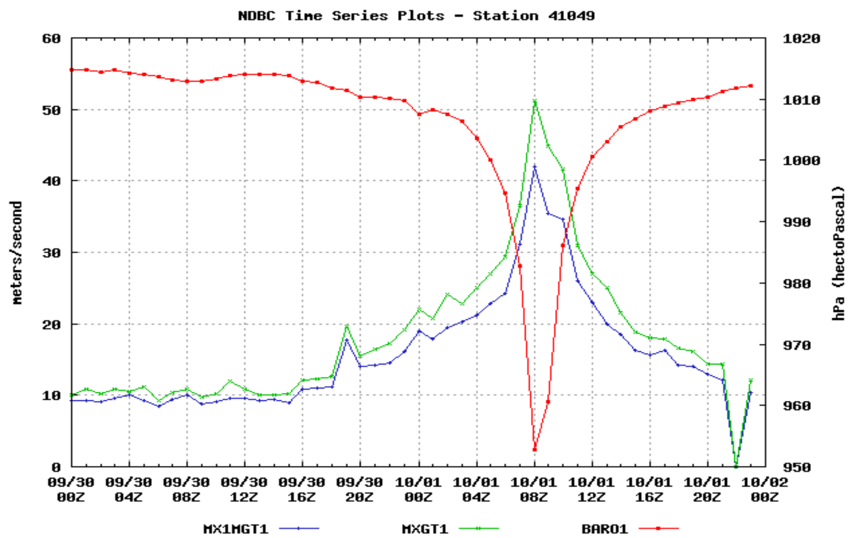

Fig. 3 - Hourly time series plots of pressure (mb), 1-minute mean wind speed (ms^{-1}), and wind gusts (ms^{-1}) from NOAA buoy 41044 (location 21.65˚N 58.69˚W) during the period 3-6 September 2011. The eye of Katia passed over or very near the buoy at approximately 1235 UTC 4 September when a minimum pressure of 968.3 mb (red asterisk) was recorded, (graph courtesy of Rex Hervey, NOAA National Data Buoy Center).

Fig. 4 - San Juan Puerto Rico doppler radar image showing the center of Irene moving over St Croix around 2300 UTC 22 August 2011

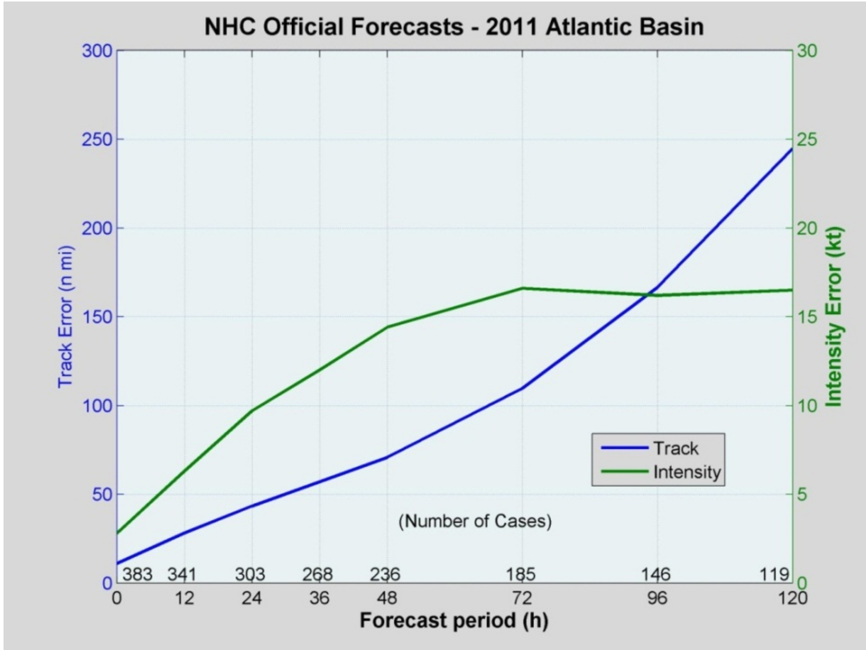

Fig. 5 - The 2011 Atlantic hurricane season had above normal activity, with 383 official forecasts issued. The NHC official track forecast errors in the Atlantic basin were lower than the previous 5-yr means at all times, except for 120 h, and set a record for accuracy at the 24, 36, 48, and 72 h forecast times. Official intensity errors for the Atlantic basin in 2011 were below the 5-yr means at all lead times, however, no records were set.

Eastern North Pacific

Tropical cyclone activity during the 2011 eastern North Pacific season was near average. Of the 11 tropical storms that formed, 10 became hurricanes and 6 reached major hurricane strength (category three or stronger on the Saffir-Simpson Hurricane Wind Scale). For comparison, the 1981-2010 averages are about 15 tropical storms, 8 hurricanes and 4 major hurricanes. Although the number of named storms was below average, the numbers of hurricanes and major hurricanes were above average. In fact, since so many recent years had been below average, 2011 had the most number of hurricanes since 2006, and the most number of major hurricanes since 1998. In terms of the Accumulated Cyclone Energy (ACE) index, which is a measure that takes into account both the strength and duration of the season's tropical storms and hurricanes, 2011 had about 113% of the long-term median value of ACE. Like most years in the basin, the bulk of the cyclone activity remained offshore of the Mexican and Central American coasts (Figure 6). However, Hurricane Beatriz affected the southwestern coast of Mexico in late June, likely bringing Category 1 hurricane conditions to the coast. Jova made landfall in the same region in mid-October as a Category 2 hurricane, causing a large area of damage and six deaths. In addition, short-lived Tropical Depression Twelve-E produced torrential rains over Guatemala, causing 36 deaths in that country.

Hurricane Adrian

A tropical depression formed on June 7 several hundred miles south of Acapulco. The depression strengthened into a tropical storm early the next day as it accelerated toward the west-northwest and northwest. As Adrian moved through an environment of light vertical wind shear and over waters near 86°F, the cyclone went through a 48-hour period of rapid intensification and became a major hurricane. After reaching its peak intensity of 140 mph on June 9, Adrian then moved across a sharp sea surface temperature gradient located southwest of Baja California, causing it to weaken rapidly and turn westward within the low-level trade winds. The system degenerated into a remnant low on June 12 while centered about 570 miles southwest of Cabo San Lucas, Mexico, with the low dissipating a couple of days later.

Hurricane Beatriz

A tropical depression formed early on June 19 about 260 miles south-southeast of Acapulco. The depression became a tropical storm later that day as it moved generally west-northwestward to northwestward around the southwestern periphery of a mid-level ridge. In a moist low shear environment over sea surface temperatures near 85°F, Beatriz quickly intensified during the next 24 hours. Data from a U.S. Air Force Reserve Hurricane Hunter mission around midday June 20 indicated that Beatriz had reached hurricane strength. Around this time, the cyclone turned north-northwestward toward Mexico and its forward speed decreased as it moved into a weakness in the subtropical ridge caused by an unusually strong trough moving through the western United States.

The intensification phase continued until Beatriz was close to the southwestern coast of Mexico early on June 21, when the hurricane reached a peak intensity of about 90 mph. The eye passed within 20 miles of the coast overnight, and the northern eye wall brushed coastal areas to the southeast of Manzanillo. The interaction of the circulation with the high terrain of the Sierra Madre del Sur likely contributed to a rapid weakening, with Beatriz becoming a tropical storm by the morning. The storm turned westward and dissipated while centered about 90 miles west of Manzanillo early on June 22.

Although the center remained just offshore, heavy rains, high waves, and strong winds affected portions of the Mexican coast from the states of Guerrero to Jalisco. The heavy rains uprooted trees and flooded homes and roads, with severe flooding reported in sections of Acapulco. The maximum reported rainfall amounts by state include 8.76 inches at Copala in

Guerrero, 6.59 inches in Lázaro Cárdenas in Michoacán, and 6.26 inches in Callejones in Colima. There was one drowning directly attributed to Beatriz.

Hurricane Calvin

Calvin was spawned by a tropical wave that reached Central America on July 3. The wave merged with a weak low pressure system embedded within the ITCZ on July 5 and two days later the low was designated as a tropical depression about 175 miles southwest of Acapulco. The depression moved west-northwestward, parallel to but well offshore of the southwestern coast of Mexico and became a tropical storm 12 hours after formation. Calvin rapidly strengthened on July 8 due to a decrease in wind shear, and the cyclone became a hurricane just 18 hours after it became a tropical storm. Calvin reached its peak intensity of 80 mph early on July 9, but started to weaken almost as quickly as it strengthened due to cooler waters. It became a tropical storm just 12 hours after reaching its peak intensity, and early the next day Calvin had degenerated into a remnant low about 410 miles south-southwest of Cabo San Lucas. The low moved slowly west-northwestward for the next few days, turning southwestward early on July 13 before dissipating the next day.

Hurricane Dora

Dora was the strongest hurricane of the season, forming from a tropical wave that entered the southwestern Caribbean Sea on July 14. As the wave neared Central America, it reached the eastern extent of an area of enhanced southwesterly flow over the eastern Pacific and Central America that was possibly associated with an eastward-moving atmospheric wave. A broad low formed and moved across Central America and became a tropical depression on July 18 about 230 miles south-southwest of San Salvador, El Salvador. In a favorable atmospheric environment over warm sea-surface temperatures, Dora steadily strengthened as it moved west-northwestward to the south of a strong deep-layer ridge. The storm became a hurricane by late on July 19 and began a period of rapid intensification. Dora attained major hurricane strength late on July 20 and reached a peak intensity of about 155 mph the next day (Fig. 7). After reaching its peak intensity, Dora turned northwestward as it moved around the southwestern periphery of the strong ridge over the central United States. Rapid weakening began late on July 21 due to an increase in northeasterly vertical shear and the cyclone moving over cooler waters. Dora became a tropical storm the next day and a tropical depression on July 24, about 250 miles west of the southern tip of Baja California. Dora degenerated into a remnant low early on July 25 and turned north-northwestward and then northward before dissipating on July 26 off of the west-central coast of the Baja peninsula.

Hurricane Eugene

Eugene was generated by the same tropical wave that caused the formation of Atlantic Tropical Storm Don. The southern portion of the wave continued westward from the Caribbean Sea, and this system developed into a tropical depression about 440 miles south of Acapulco early on July 31 and strengthened into a tropical storm 6 hours later. Steady development occurred as the storm was moving toward the west-northwest, and Eugene became a hurricane late on August 1. The cyclone intensified more rapidly on August 2, and Eugene became a major hurricane with a peak intensity of about 140 mph the next day. The eye rapidly lost definition due to the cyclone's passage over waters below 75°F by late on August 4 and Eugene rapidly weakened to tropical storm intensity on August 5. The system became a remnant low on August 6, turned westward and southwestward in the low-level trade winds and eventually decayed into a trough a few days later about a thousand miles east of Hawaii.

Tropical Storm Fernanda

The tropical wave that produced Atlantic Tropical Storm Emily likely played a role in the genesis of Fernanda. After crossing Central America, the wave entered the eastern North Pacific on August 6, where it produced periods of intermittent deep convection as it moved slowly westward. By late on August 15, the associated showers and thunderstorms became better organized, and a tropical depression formed about 1600 miles east-southeast of Hawaii. The system strengthened into a tropical storm early the next day, but persistent east-northeasterly shear inhibited significant development. A reduction in the shear late that day led to intensification as the cyclone turned west-northwestward, and Fernanda reached its peak intensity of 70 mph before crossing into the Central North Pacific basin on August 18. Gradual weakening then occurred as Fernanda encountered less conducive thermodynamic conditions. The cyclone eventually lost all of its convection, and it degenerated into a remnant low on August 20. The low turned westward and dissipated the next day a couple hundred miles south of Hawaii.

Hurricane Greg

Greg formed from a tropical wave that crossed Central America on August 14. This system led to the development of a tropical depression about 175 miles south-southeast of Acapulco late on August 16. The depression slowly intensified within an easterly shear environment and became a tropical storm early on August 17. After the shear relaxed somewhat, Greg became a hurricane early on August 18 about 230 miles south-southwest of Cabo Corrientes, Mexico. Greg reached a peak intensity of 85 mph and continued to move toward the west-northwest for about another day and then westward thereafter. By then, a portion of the circulation had reached increasingly cooler waters and a more stable environment, resulting in a decrease in convection and the disappearance of the eye. Greg weakened to a tropical storm and then degenerated into a remnant low on August 21. The low continued to move westward and dissipated two days later.

Hurricane Hilary

Hilary developed from a tropical wave that reached the eastern Pacific on September 16 and began interacting with the ITCZ. A broad low formed on September 18 and deep convection gradually increased enough to cause a tropical depression to form early on September 21, about 350 miles southeast of Acapulco. Due to favorable environmental conditions, Hilary underwent a prolonged period of rapid intensification as it moved westward, which resulted in the small cyclone reaching its lifetime peak of 145 mph, Category 4 on the Saffir-Simpson Hurricane Wind Scale. Hilary then underwent an eyewall replacement cycle with some weakening of the cyclone to a Category 3 hurricane. The environment remained conducive for intensification, however, and after the eyewall cycle was completed, a secondary maximum in intensity of 135 mph occurred by early on September 27. A steady weakening of the cyclone started after that time due to its passage over cooler waters. From September 28-30, Hilary moved toward the northwest as a mid to upper-level low eroded the subtropical ridge north of the cyclone. Hilary weakened to a tropical storm early on September 29 about 670 miles west-southwest of the southern tip of Baja California. Under continued hostile conditions, Hilary further decayed to a remnant low a day later. The low then meandered generally toward the southwest over the next three days before dissipating about a thousand miles west of the southern tip of Baja California. Although Hilary remained offshore of Mexico, there were three direct deaths due to Hilary; three fishermen perished when their boat sank off of the town of Marguelia.

Hurricane Irwin

The late season was relatively busy in the eastern Pacific with the formations of Irwin and Jova in October, along with Kenneth in November. Irwin is most notable for its unusually long-lived eastward track that brought the cyclone from several hundred miles south of Baja California to near the southwestern coast of Mexico. The tropical cyclone originated from a disorganized low pressure area from the ITCZ on October 4 and a tropical depression formed about 850 miles south-southwest of Cabo San Lucas. The system rapidly became a hurricane within 24 hours and reached a peak intensity of 100 mph. Irwin then encountered increasing shear from the upper-level outflow of Jova as Irwin turned toward the northeast and east. The increase in shear caused the hurricane to rapidly weaken to a tropical storm by late on October 8. Over the next three days, Irwin accelerated toward the east as a weak tropical storm, steered by the flow around a developing cut-off low southwest of Baja California. As Irwin turned toward the northeast late on

October 12, deep-layer shear increased further, and Irwin weakened to a tropical depression a few hundred miles west-southwest of Manzanillo. The system became a tropical storm again as it turned to the south, but weakened again on October 15, partially due to it moving over the cold wake from Jova. Irwin degenerated to a remnant low 24 hours later and moved slowly northwestward for another two days or so before dissipating.

Hurricane Jova

Early on October 5, a circulation developed along the ITCZ and become better defined throughout the day about 500 miles south-southwest of Acapulco. Deep convection became more concentrated near the center over the next 12 hours, and a tropical depression formed early on October 6. After genesis, the depression moved generally west-northwestward around the southwestern periphery of a subtropical ridge and reached tropical storm intensity later that day. Moderate northeasterly vertical wind shear on October 7-8 led to only gradual strengthening, and during this time the cyclone's forward speed decreased as it turned northwestward and then northward around the western edge of the ridge. By late on October 8, the vertical shear decreased and Jova became a hurricane about 425 miles west-southwest of Manzanillo. The hurricane steadily strengthened during the next couple of days as it moved north of the ridge and turned toward the east. Jova reached major hurricane status early on October 10, with a peak intensity of 125 mph later that day around the time the hurricane formed a distinct eye.

By early the next day southwesterly shear increased over Jova ahead of a mid-latitude trough digging southward over the Baja California peninsula. This increase in shear resulted in gradual weakening as the cyclone turned northeastward ahead of the trough, and Jova fell below major hurricane status on October 11. While accelerating north-northeastward later that day, the hurricane maintained an intensity of 100 mph and approached the coast of the Mexican state of Jalisco. Jova made landfall at that intensity around midnight October 12, near the town of El Tabaco. After landfall, Jova continued moving north-northeastward, rapidly weakened over the high terrain of western Mexico, and completely dissipated by October 13.

There were six deaths in Mexico due to the hurricane. A woman and her son were killed in a mudslide in Chiuatlán, in the state of Jalisco, with another man drowning in a river. In Tomatlan, a man and a teenage boy were killed when their house collapsed due to heavy rain. In the state of Colima a woman drowned when her car was swept away by water. The port of Manzanillo was closed, with reports of wind damage to power lines and billboards and flooding that knocked out at least one bridge in that city. Flooding was also reported in Zihuatian, Melaque, and Barra de Navidad. A total of 107,000 people lost power due to the storm and 2,600 people were evacuated by the Mexican Navy.

Hurricane Kenneth

Kenneth was notable as the latest major hurricane ever observed in the basin, easily eclipsing the previous record of Xina in late October 1985 by about three weeks. The tropical wave that helped spawn Kenneth moved into the basin on November 16, accompanied by a broad low with showers and thunderstorms. The convection became better organized and a tropical depression formed late on November 19 about 465 miles south of Acapulco. Initially the depression changed little in organization, but it began to rapidly intensify late on November 20. Kenneth reached its peak intensity of 145 mph on November 21 with a small, well-defined eye noted in satellite imagery. The hurricane continued to move toward the west, and quickly weakened on November 22 due to less favorable environmental conditions. Kenneth weakened to a tropical storm on November 23 about 400 miles south-southwest of Clarion Island, and degenerated to a remnant low a couple of days later over cooler waters.

Table 2 - 2011 eastern North Pacific summary table.

Storm Name	Class*	Dates**	Maximum Winds (mph)	Minimum Central Pressure (mb)	Deaths
Adrian	MH	June 7-12	140	944	
Beatriz	H	June 19-22	90	977	1
Calvin	H	July 7-10	80	984	
Dora	MH	July 18-24	155	929	
Eugene	MH	July 31 –August 6	140	942	
Fernanda	TS	August 15-19	70	994	
Greg	H	August 16-21	85	979	
Hilary	MH	September 21-30	145	940	3
Irwin	H	October 6-16	100	977	
Jova	MH	October 6-12	125	955	6
Kenneth	MH	November 19-25	145	940	

* TD – tropical depression, maximum sustained winds 38 mph or less; TS – tropical storm, maximum sustained winds 39 – 73 mph; H – hurricane, maximum sustained winds 74 – 110 mph; MH – major hurricane, maximum sustained winds 111 mph or higher.
** Dates based on UTC time and include tropical depression stage.

Note: The Accumulated Cyclone Energy (ACE) index is a measure of the collective strength and duration of all tropical storms and hurricanes during the year, calculated by adding up the squares of the maximum wind speeds (in knots) at six-hour intervals for each storm.

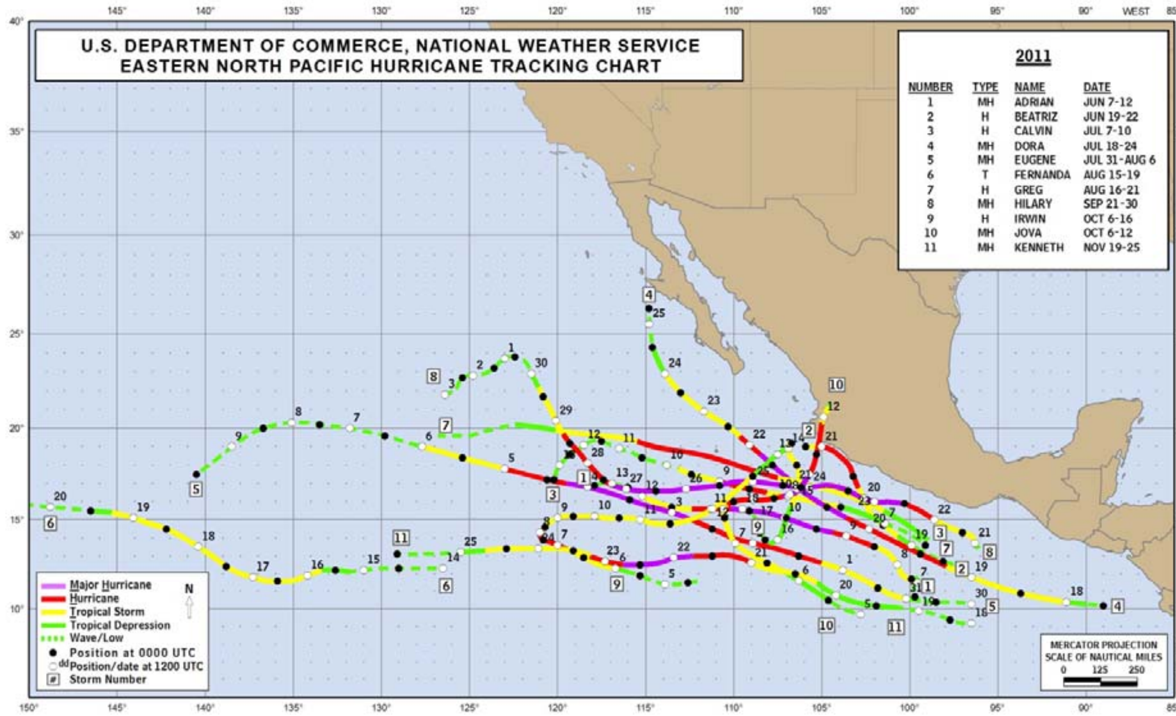

Fig. 6 - 2011 eastern North Pacific Tropical Storms and Hurricanes

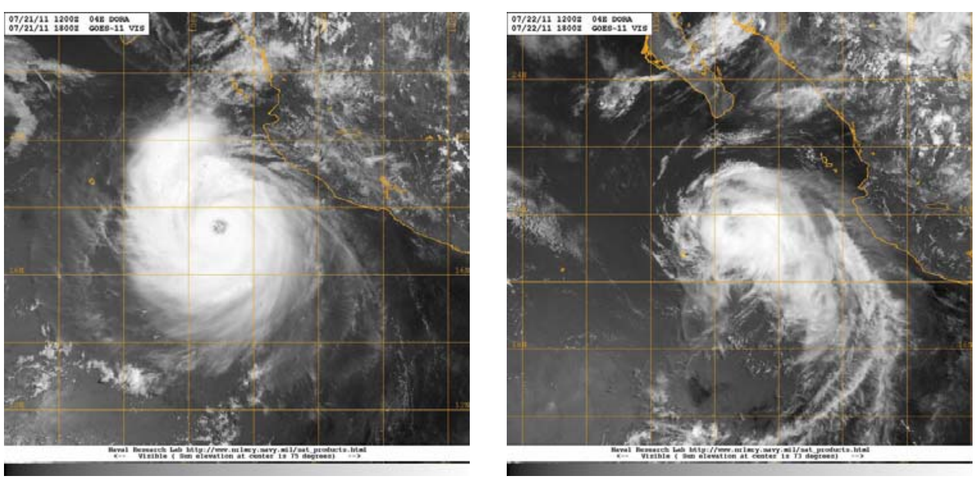

Fig. 7 - GOES-11 visible satellite imagery of Dora shortly after peak intensity at 1800 UTC 21 July (left) and 24 h later (right), after the tropical cyclone rapidly weakened to a tropical storm.Images courtesy of theNaval Research Laboratory.

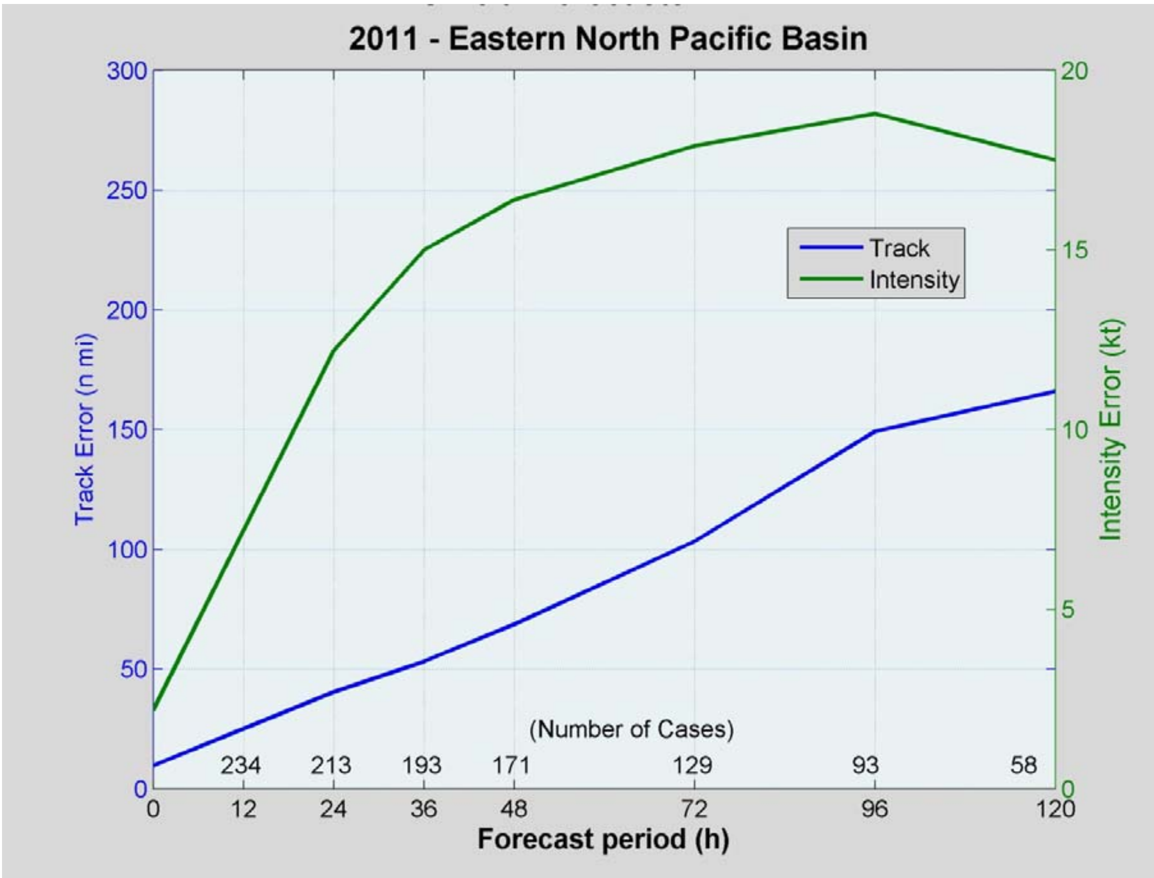

Fig. 8 - There were 258 official forecasts issued in the eastern North Pacific basin in 2011, although only 58 of these verified at 120 h. This level of forecast activity was near normal. NHC official track forecast errors set new records for accuracy at 12 h. For intensity, the official forecast errors were lower than the 5-yr means at all times, except 120 h. This result is particularly impressive as the 2011 Decay-SHIFOR errors were up to 30% larger than their long-term mean.

REVIEW OF THE PAST HURRICANE SEASON

REPORTS OF HURRICANES, TROPICAL STORMS, TROPICAL DISTURBANCES AND RELATED FLOODING DURING 2010

(Submitted by Members of the RA IV Hurricane Committee)

Reports are posted on the WMO/TCP Website along with the main report

APPENDIX V

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

I. **METEOROLOGICAL COMPONENT**

TASKS							BY WHOM	RESOURCES	COMMENTS	
		2012	2013	2014	2015	2016				
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	
1.1.3	Implementation of Quality Management Systems in support of Meteorological Services and associated activities						Members	National and external assistance	With advice of WMO, where needed	

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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	
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	NMHSs continue the practice of sending observations to RSMC Miami 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	

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I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS	
		2012	2013	2014	2015	2016				
1.2.2	**Upper-air stations**									
1.2.2.1	Establishment of the following upper-air stations:									
	Guatemala						Guatemala	) National and		
	80400 Isla de Aves - radiosonde						Venezuela	) external assistance		
1.2.2.2	Implementation of two rawinsonde observations per day at all rawinsonde stations throughout the active portion of hurricane season, July through October*						Members concerned	National and external assistance		
1.2.2.3	Maintaining two rawinsonde 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		
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		
1.2.2.5	Establishment of Hydrogen generation in support of Upper air programme in Bermuda, to mitigate rising cost of helium						Bermuda	National		

*During 2012-2013 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS	
		2012	2013	2014	2015	2016				
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									
	• Designating Port Meteorological Officers						Members	National		
							Members	National		
1.2.3.2	Improvement of communications between Meteorological Services and ships, to request 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		

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS	
		2012	2013	2014	2015	2016				
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							BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
1.2.4.3	Establishment of automatic weather stations at the following locations:								
	Dominican Republic (10) remainder to be installed by 2013						Dominican Republic	National & USA	
	Panama 30 auto stations available on the web						Panama	National and external assistance	
	Guatemala (32)						Guatemala		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
	Cuba (30)						Cuba		
	Dominica (12)						Dominca		
	Trinidad (3)						Trinidad		
	Jamaica (3)						Jamaica		
	Belize(5)						Belize(1)		
	Haiti (6)						Haiti/WMO		
	Aruba (2)								
	El Salvador (22).							National (BCIE funds, PNRR program)	10 in 2012 : 10 Met stations, + 4 pluviometric, + 8 hidrology by 2013
	Nicaragua (30)								(4 climo, 8 hydroclim, 14 thermopluvial, 4 pluviometric)
	Honduras (15)								
	Venezuela (490)								
	Curacao (5 in 2012, 5 in 2013)								
1.2.4.4	Ensure the quality control and sharing of AWS weather data to the international met community.								

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS	
		2012	2013	2014	2015	2016				
1.2.5	**Radar stations**									
1.2.5.1								National & European Union	Being implemented	
	Installation of radar in Cayman Islands						BCT (Cayman Islands)			
1.2.5.2	Establishment and operation of 10 cm/5.6 cm wavelength radar stations at the following locations or nearby:							National & External Assistance		
	El Salvador 8 X-band (3cm) radars by 2013						El Salvador	National (BCIE funds, PNRR program		
	Cuba (Camaguey in 2012, Havana dual polimetric radar by 2013)							National		
	Honduras (1)						Honduras			
	Guatemala (1)						Guatemala			
	Costa Rica (1)									

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
1.2.5.3	Speedy availability of 10 cm/5.6 cm radar data 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* (CMO, France to provide text updates)						France	USA and France	France produces composites based on 5 radars**; USA provide the telecommunication facilities.

*During 2012-2013 items with an asterisk to be given priority attention

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS	
		2012	2013	2014	2015	2016				
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		

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I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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	
1.2.7.3	Panama GOES Satellite receiving station installation								

*During 2012-2013 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
1.2.8	**Storm surge and Waves**								
1.2.8.1	Establishment of a network of tide-gauge stations in coastal areas where storm surges are likely to occur, and in coordination with tsunami mitigation activities						Members able to do so	National	Data should be provided in near real-time
1.2.8.2	Bahamas - wave buoys being repaired and will become operational						Bahamas	National	
1.2.8.3	El Salvador - Installation of two (2) current and wave buoys. One at the Acajutla port and La Unión port.						El Salvador	National	
1.2.8.4	Dominican Republic – update to be provided						Dominican Republic	National	

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
1.2.9	**Lightning detection systems**								
1.2.9.1	Installation of a high resolution lightning network for the Lesser Antilles						France, CMO	To be identified	1st phase explore networks available to find one best suited for the region to be upgraded or installed.
1.2.9.2	Dominican Republic - Lightning detection network being developed for use by region and RSMC Miami						Dominican Republic		

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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	

*During 2012-2013 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
1.3.2.2	Implementation, where necessary, of national and international communication links for distribution of warnings and advisories						Members	National and external assistance	
1.3.3	Regional telecommunication network								
1.3.3.1	Continue to improve & upgrade telecomm. systems in accordance with the RA IV Regional Meteorological Telecomms Plan,*						Members		
1.3.3.2	Promote installatio n of EMWIN systems						USA	External Assistance &	
								National budget	
							Members		
1.3.3.3	El Salvador, 3 EMWIN systems					El Salvador	NOAA USA		
1.3.3.4	El Salvador, 5 GEONETCAST systems					El Salvador	NOAA USA		
1.3.3.5	Migration to new GTS system						All Members		ISCS broadcast scheduled to end in June 2012

*During 2012-2013 items with an asterisk to be given priority attention

I. METEOROLOGICAL COMPONENT

TASKS							BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
1.4 HURRICANE AND STORM SURGE SIMULATION, FORECASTING AND WARNING									
1.4.1	Storm surge project activities								
1.4.1.1	Develop storm surge maps and undertake hazard assessment activities*						Members	National and external assistance including TCDC	With advice of WMO; IOC
							Members		
							Bahamas		Digitized format ; Resolution 0.1 to 1.0 nautical mile
							Members		
							CIMH		
1.4.1.2	Undertake bathymetric and topographic data collection*								
	Bahamas – atlases of coastal inundation are being updated						Bahamas		
1.4.1.3	Enhance storm surge map coverage by using SLOSH								

*During 2012-2013 items with an asterisk to be given priority attention

I. **METEOROLOGICAL COMPONENT**

TASKS							BY WHOM		COMMENTS
		2012	2013	2014	2015	2016			
1.4.1.4	Include the tsunami and other coastal hazards early warning system community in storm surge modelling and hazard assessment activities								
1.4.1.5	CIMH in collaboration with UWI and the World Bank will develop a series of storm surge hazard maps for the Caribbean Region								
	Provide bathymetric data towards the development of a local circulation model and inundation risk maps, which will facilitate assessment and real time forecasting of impacts from storm surge, tsunami and other coastal hazards.								

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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	his 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
		2012	2013	2014	2015	2016			
2.2 HYDROLOGICAL FORECASTING									
2.2.1	Establishment, improvement and/or expansion of hydrological forecasting (including flash floods) and warning systems in flood-prone areas, and in particular: (a) The countries indicated to be invited to consider the establishment/ expansion of systems in the:							National	
	• YAQUE DEL SUR river basin						Dominican Republic		
	• YAQUE DEL NORTE river basin						El Salvador and Honduras		
	• RIO LEMPA						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 SARAPIQUI						Costa Rica		

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
2.2.1 (cont'd)	Establishment, improvement and/or expansion of hydrological forecasting (including flash floods) and warning systems in flood-prone areas, and in particular: (b) Establishment of flash flood warning systems in flood-prone areas; (c) Promote the use of hydrological models to forecast the behaviour of rainfall and run-off characteristics, paying special attention to the use of radar and satellite information.						Members concerned Members concerned	National National	
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
		2012	2013	2014	2015	2016			
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	

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
.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

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
2.3.7	Basic studies on the vulnerability of the monitoring networks to damage caused by tropical storms, taking into account also the problems which might be generated when stations become inoperative, both with regard to the interruption of the available historical series and to the provision of observations and data of subsequent events						Interested Members	National and TCDC	
2.3.8	Basic studies on the intensity and spatial variability of rainfall produced by all tropical storms during the tropical cyclone season, as well as on the optimal density of the recording rainfall network required						Interested Members	National and TCDC	
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	

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
2.3.12	Establishment of a regional project to generalize the hydrological impact knowledge of tropical storms and hurricanes**						Interested Members	National and TCDC	
2.4 TRANSFER OF HYDROLOGICAL TECHNOLOGY									
2.4.1	Attention to the availability through HOMS of components and sequences containing hydrological technology suitable for the hydrological component of the technical plan*						Members	National and TCDC	With advice of WMO
2.4.2	Undertaking a promotional effort among Member countries, so that they may develop HOMS components reflecting in particular experiences in regions affected by tropical storms; the Committee to encourage the inclusion of the components in the HOMS Reference Manual						Hurricane Committee in cooperation with its Members	National and TCDC	

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

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

APPENDIX V

III. DISASTER REDUCTION AND PREPAREDNESS

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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. The Hurricane Committee will nominate a representative to attend meetings of the Sessions of the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG)						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	

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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	
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
		2012	2013	2014	2015	2016			
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
		2012	2013	2014	2015	2016			
4.1 TRAINING OF METEOROLOGICAL PERSONNEL									
4.1.1	Assessment of current and expected future needs for the training of specialized staff to man their warning systems at all levels under the following headings:								
	(a)Those capable of being met through training facilities already available in Member countries*						Members	National	
	(b)Those for which assistance from external sources is needed*						Members	National	With advice of WMO
	Take appropriate steps to organize such training programmes*						Members	National and external assistance	
4.1.2	Support as appropriate and make full use of the training facilities offered at the WMO Regional 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 2012-2013 items with an asterisk to be given priority attention

IV. TRAINING COMPONENT

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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 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	Storm surge and coastal hazards training is a vital need for the region, and must be continued following the outcomes of the workshop in Dominican Republic								
4.1.6	Arrangements for exchange working visits of Staff between operational and training centres						Members, training centres	National and external assistance, regional projects, TCDC	

*During 2012-2013 items with an asterisk to be given priority attention

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
4.1.7	Specific training for forecasters from Haiti Ongoing training for techinicians should also be implemented						France, USA	To be determined	
4.1.8	Specific training short courses one week of Hurricane Forecast, Calibration Radar Band X , Landslide Hazard, LIDAR.							El Salvador	WMO NOAA

IV. <u>TRAINING COMPONENT</u>

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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. Courses and workshops on hydrological forecasting techniques or data acquisition, processing and analysis						Members concerned USA or other Members concerned	National and external assistance National and external assistance	

TASKS		TIMESCALE					BY WHOM	RESOURCES	COMMENTS
		2012	2013	2014	2015	2016			
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
		2012	2013	2014	2015	2016			
5.1 RESEARCH									
5.1.1	Making readily available information on research activities and results carried out in Member countries to other Members of the Committee with a view for transfer to operational application as appropriate *						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 2012-2013 items with an asterisk to be given priority attention