

WORLD METEOROLOGICAL ORGANIZATION

**RA IV HURRICANE COMMITTEE
THIRTY-EIGHTH SESSION**

**SAN JUAN, PUERTO RICO
(21 to 26 April 2016)**

FINAL REPORT



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1. ORGANIZATION OF THE SESSION

At the kind invitation of the Government of the United States of America, the thirty-eight session of the WMO Regional Association (RA) IV Hurricane Committee was held in San Juan, Puerto Rico from 23 to 26 April 2016.

The inauguration ceremony for the Meeting took place at 9:00 am Saturday 23 April 2016, and it included the following speakers:

- 1) Prof Petteri Taalas, Secretary-General, World Meteorological Organization;
- 2) Ms Laura Furgione, Permanent Representative of the United States of America to the World Meteorological Organization;
- 3) Dr Richard Knabb, Director of the NWS' National Hurricane Center and Chairman of the Hurricane Committee of RA IV;
- 4) Mr Juan Carlos Fallas Sojo, Permanent Representative of Costa Rica to the World Meteorological Organization and President of the WMO Regional Association IV.

1.1 Opening of the session

1.1.1 Dr Richard Knabb, Chairman of the RA IV Hurricane Committee, highlighted the importance of the Meeting for the continued collaboration among all of the countries in RA IV on meteorological and technical issues. He also described the importance of the work of this Committee and each country for disaster safety throughout the region.

1.1.2 Prof Petteri Taalas, Secretary-General of WMO, welcomed all the participants and expressed WMO's appreciation to the Government of the United States for hosting the thirty-eight session of the Hurricane Committee. He also expressed his gratitude to the United States of America for the services of the RSMC Miami-Hurricane Centre.

Prof Taalas mentioned that in the last two years we witnessed a number of very severe tropical cyclones around the globe: severe tropical cyclone Ian hitting Tonga in January 2014; severe tropical cyclone Pam devastating Vanuatu in March 2015; in early September last year, four tropical cyclones at the same time in the North Pacific; Yemen hit by tropical cyclones in late October and early November 2015 with unusual frequency; in 2015 and early this year, Azores in the northeast Atlantic and Cabo Verde in East Atlantic unusually and severely affected by hurricanes; very severe tropical cyclone Winston hitting Fiji in February 2016.

He underlined that despite these extreme and exceptional events, it has been recognized that losses of lives caused by those unprecedentedly strong tropical cyclones were minimal compared with similar events which occurred 20 years earlier.

The significant reduction of disaster risks by tropical cyclones in terms of loss of lives and properties can be credited to the well-established nationally and regionally coordinated early warning mechanisms under the Tropical Cyclone Programme (TCP). These mechanisms have been in place around the clock, in particular, in the six Regional Meteorological Specialized Centres (RSMCs) and the six Tropical Cyclone Warning Centres (TCWCs) provided accurate and timely forecasting advisories to enable the relevant national centres to issue their accurate and reliable early warnings on tropical cyclone movements, strong wind force and associated storm surges.

Last year the 17th WMO Congress approved the Strategic Plan of the Organization and provided guidance to the work of the TCP. The Congress requested to give high priority to capacity development in tropical cyclone forecasting, particularly in Small Island Developing States (SIDS) and Least Developed Countries (LDCs) and make the necessary arrangements to extend training activities to cover all the five regional tropical cyclone bodies. All these efforts require coordination and collaboration in holistic and systematic approaches, for example coordination of TCP with the Data Processing and Forecast System (DPFS) and other programmes, tropical cyclone regional bodies and RSMCs/TCWCs to facilitate the wider use of the new Global Guide on tropical cyclone forecasting from a multi-hazard point of view.

While the timeliness of hurricane warnings and the accuracy of track forecasts have been improving steadily over the last decades, there is still a need for increased warning lead time for enhanced response. In addition, users demand forecasting and warning information based on impacts and risks. A coordinated approach to Disaster Risk Reduction (DRR) is critical to the implementation of the 2030 Agenda and the Sustainable Development Goals (SDGs).

Yet, in some Members of the Region forecasting and warning services for tropical cyclones are still insufficient to ensure the safety of all their citizens. This requires a stronger interaction between the National Meteorological and Hydrological Services (NMHSs) and the national agencies in charge of disaster risk reduction, in order to increase the effectiveness of early warning systems and the associated mitigation actions.

These are areas of particular concern to WMO and we should capitalize on the lessons learnt from past experience, in particular the need to develop a technical guide to facilitate the Members under threat by tropical cyclones to take the necessary early actions. Prof Taalas mentioned that the session offered an opportunity to develop strategies for coordinated actions and he was confident that the outcomes would be beneficial for all Members of the Committee.

Prof Taalas assured of WMO's continued support through TCP for the Committee's programmes and activities, and wished all the participants a very successful session and an enjoyable stay in Puerto Rico.

1.1.3 Mr Fallas Sojo said that, having welcomed the participants to Costa Rica a year ago, he would now like to take this opportunity to thank Puerto Rico for its hospitality and support in attaining the goals and objectives of this thirty-eighth session of the Regional Association IV Hurricane Committee.

He went on to say that those who, in their various ways, deal with the daily business of meteorology and all the various aspects of the environment were facing the constantly changing behaviour of the atmosphere, the oceans and the environment as a whole. This means that discussion forums and hard work, such as that of this Committee, call not only for vast experience, but also for commitment on the part of individuals and the meteorological and hydrological services represented.

The passage of years, combined with the hard experience gained from the direct or indirect impact of tropical cyclones in committee members' countries, has taught that every effort helps protect lives and homes throughout the region, as well as in other parts of the world.

The endeavours of the committee and of each service contribute to strengthening the culture of prevention, through the implementation of up-to-date systematic observation and early warning systems as well as education and awareness-raising among societies and decision-makers. Because of this, the work of this committee has been based not only on Internet technology, fast, high-capacity computers, satellites and ever more innovative prediction models, but also on close cooperation and contributions across the whole region and on individual efforts to organize actions within a framework of coherence and solidarity.

The steadfast commitment and disciplined teamwork of this committee has been a real hive of activity, becoming known by the name "CAMUATÍ": CA standing for bee; MU for friendship and ATÍ for meeting; in other words, "bees gathering in friendship". Thus, the participants, united in one "hive", have been spurred on to produce the best honey once again: may the sting of their actions be the catalyst for well-being in their respective communities.

1.1.4 Ms Furgione, United States National Oceanic and Atmospheric Administration Deputy Assistant Administrator for Weather Services and the Deputy Director of the United States National Weather Service and Permanent Representative of the United States to the WMO, declared the 38th session of the WMO RA-IV Hurricane Committee open.

Ms Furgione said that the Committee seeks to improve tropical cyclone prediction and coordination in the Region by bringing Members together on an annual basis to address issues such as data collection requirements, operational and technical coordination, research priorities and transition to operations, forecast practices and procedures, outreach, and training.

Ms Furgione thanked the Members for their active participation in all of the Region's collaborative activities and for the support of efforts in the U. S. to serve effectively as the RSMC.

She said that the United States always have and always will take very seriously the international mandate and regional responsibility to coordinate tropical cyclone advisories with up-to-date meteorological information for the North Atlantic, the Caribbean Sea, the Gulf of Mexico, and the eastern North Pacific. RSMC Miami's

interactions with all the participants during the hurricane season are frequent, and collective success depends on mutual trust, respect, and effective and open communications.

Issuing the best possible official tropical cyclone forecasts and products and providing guidance to regional partners are the highest priorities for RSMC Miami, which is also the world leader in operational tropical cyclone forecasting and in communicating the associated hazards with revolutionary products, such as the new 5-day Tropical Weather Outlook, and the Potential Storm Surge Flooding Map that was going operational for continental U. S. landfall threats in 2016 or the issuance of advisories for some land-threatening systems even before the formation of a tropical cyclone.

She added that this Region was the gold standard for international collaboration on tropical cyclones. The hydrometeorological services of the Caribbean, North and Central America and the United States through RSMC Miami have a long history of effective collaboration, strong relationships, and an insatiable desire to keep learning and improving.

Ms Furgione also mentioned the WMO workshop for international meteorologists at RSMC Miami, other training courses, and outreach events such as the Caribbean Hurricane Awareness Tour.

The Hurricane Committee meeting was a tremendous opportunity to gain a greater understanding of how our evolving meteorological and hydrological services would operate in 2016, to enhance the benefits of shared data, forecast information, and training efforts, to learn key lessons from the impacts in 2015, and to update our regional procedures and plans so that members can perform together in 2016 and without underestimating the long-term value of the deep relationships developed between one another over the years.

Ms Furgione expressed her gratitude to the sponsors and to the WMO and its representatives and concluded her speech by saying that she was confident that the WMO would again be proud of the RA IV Hurricane Committee accomplishments at this meeting and what the Members do in service together throughout the upcoming hurricane season.

1.1.5 The session was attended by 51 participants, representing 26 RA IV Member States of the Committee, observers from Spain and regional and international organizations. The list of participants is given in **Appendix I**.

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 Dr Richard Knabb, the Chairman of the Committee, discussed the activities of RSMC Miami as described in this section.

2.2 The WMO/RSMC Miami attachment program continued in 2015 with participants from Haiti, Honduras, Mexico, and the Dominican Republic. This program helps hurricane warning coordination in the region during tropical cyclone events while meteorologists from the region gain valuable training in hurricane forecasting. RSMC Miami and WMO strongly encouraged WMO RA IV Permanent Representatives to continue to support this program. The announcement requesting candidates for 2016 would be sent by the Region IV President in late April or early May 2016.

2.3 Reconnaissance aircraft plays an extremely important role in monitoring the track and intensity of tropical cyclones. During the 2015 season, the U.S. Air Force and NOAA Reconnaissance Hurricane aircraft provided valuable meteorological data not available from any other sources. Data from both NOAA and Air Force hurricane hunter aircraft helped to determine the intensity of Hurricane Patricia which became the strongest hurricane on record in the eastern North Pacific. NOAA (USA) and SMN (Mexico) reaffirmed the agreement of having a NOAA-P3 reconnaissance plane based in Mexico during the hurricane season to facilitate flights into eastern North Pacific tropical cyclones.

2.4 The agreement between RSMC Miami and the Mexican Air Force to coordinate reconnaissance hurricane flights over Mexican airspace continued in 2015. Meteorologists from the Mexican Air Force were stationed at the RSMC Miami, and helped coordinate timely clearances for hurricane surveillance and reconnaissance flights during tropical cyclone events that had the potential to affect Mexico. These flights were especially crucial in Hurricane Patricia. Their efforts helped improve the overall efficiency of the Hurricane Warning Program. The Chair urged the continuation of this program in 2016 and a letter of invitation has been sent to the Mexican Air Force.

2.5 The WMO RA IV Workshop on Hurricane Forecasting and Warnings and Public Weather Services was held at RSMC Miami 29 February - 11 March 2016. This year's workshop was conducted in English and Spanish. The Chair strongly supports that the workshop continues to be offered in English and Spanish every other year due to the importance to the region's hurricane program.

2.6 The Eighth RSMC coordination meeting took place in Miami from 2 to 6 November 2015 and results were reported to the Committee.

2.7 RSMC Miami's Potential Storm Surge Flooding Map would become operational in 2016. This included making available the underlying geospatial data. The map/data would be issued for areas along the Gulf and Atlantic coasts of the United States. This map showed the height above ground level, in feet, that inundation originating from storm surge could reach.

2.8 RSMC Miami would also issue a prototype storm surge watch/warning graphic in 2016 to highlight areas at greatest risk of life-threatening inundation from storm surge along Gulf and Atlantic U.S. coasts. This graphic introduced the concept of a storm surge watch and warning currently which was planned for operational implementation in 2017.

2.9 RSMC continues development work to provide the option to issue timely tropical storm and hurricane watches and warnings for disturbances that have a significant potential of becoming a tropical cyclone during the period when the watch or warning would otherwise be in effect. The watches and warnings would be issued through the standard suite of RSMC advisory products using the "Potential Tropical Cyclone" Mass News Disseminator header. These forecasts and warnings was expected to be publically issued beginning in 2017.

2.10 RSMC Miami was working on a new graphic to highlight the reasonable earliest arrival time of tropical-storm-force winds. This graphic incorporated typical forecast uncertainty in the same manner that the current NHC wind speed probabilities account for track, intensity, and size uncertainties. This product was expected to be issued experimentally as early as 2017.

2.11 During 2014, at WMO RA IV Hurricane Committee Meeting in Cancun, the Member States expressed a strong desire to receive storm surge training and more technical information on how to build storm surge models. The first-ever storm surge training workshop for the RA IV was hosted by RSMC Miami in January 2015 to begin understanding regional requirements for improved storm surge forecasting capabilities. Using information and feedback obtained from the aforementioned workshop, RSMC Miami and WMO developed a project proposal for a Caribbean Coastal Inundation Forecast Demonstration Project (CIFDP C). The project proposal was funded by USAID in 2015 for a 3-year demonstration in Haiti and the Dominican Republic (i.e. one island approach).RSMC Miami and the WMO held a workshop in Santo Domingo in 2015 to collect user requirements and develop a project plan. RSMC Miami provided a 1-year project status update at the 2016 RA-IV Hurricane Committee meeting. Anticipated project completion was 2017. New funding avenues are being pursued for storm surge development activities beyond 2017 to extend the initial demonstration project to other Member States.

2.12 The Latin America Caribbean Hurricane Awareness Tour (LACHAT) took place from 19 to 26 April 2015. The U.S. Air Force C-130 (J-model) Hurricane Hunter plane visited Merida, Cozumel, Mexico, Bonaire, Santo Domingo, St Kitts, St. Eustatius and Puerto Rico. This year's LACHAT would include a visit to Cabo San Lucas and Puerto Vallartain Mexico, Tegucigalpa in Honduras, Tortola and Puerto Rico. This project increases 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 enhances the visibility of the participating country's weather forecasting and emergency management offices. Furthermore, the Committee was informed that it was not possible to visit Tegucigalpa, since the plane could not land due to poor weather conditions. It was agreed, however, to carry out the visit in 2017.

2.13 RSMC Miami and the Chairman greatly appreciated the radar imagery received operationally from RA IV Members during the 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. Radar data from the Caribbean Islands were extremely important in determining the structure and evolution of Erika in 2015.

2.14 Surface and upper air observations are very essential to the operational forecasts of the RSMC Miami. The Chair appreciated the members' efforts to maintain their observation and communication systems, especially the data received from countries during and after tropical cyclone events. The United States NWS would provide an update related to upper-air soundings primarily for CHUAS network participants. Once again, data from the Mexican Navy Automatic station network (SEMAR) were very useful in tracking several of the tropical cyclones in 2015.

2.15 The Chairman thanked the Members of the Committee affected by tropical cyclones for the submission of their post-storm country reports. These reports were vital to the preparation of the RSMC Miami Tropical Cyclone Reports. The Chairman encouraged members to use the format provided in the Hurricane Operational hurricane Plan approved by the Region. SMN, Mexico also provided RSMC Miami with total rainfall maps associated with tropical cyclones.

2.16 During the 2015 hurricane season, the 5-day Graphical Tropical Weather Outlook (GTWO) became operational.

2.17 A summary of all non-tropical cyclone products issued by NHC/TAFB were also presented to the Hurricane Committee.

2.18 Coordination between RSMC Miami and the U.S. Department of State Crisis Operations Center continued during hurricane events to with the U.S. Embassies in the RA IV countries.

2.19 As part of the United States Weather Research Program (USWRP), the Joint Hurricane Testbed (JHT) was one of the primary avenues to evaluate research projects with the goal of transitioning successful projects into operations.

2.20 The NOAA Hurricane Forecast Improvement Program (HFIP) was a multi-agency effort to improve tropical cyclone track and intensity forecast. 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. Promising output was made available in or near real time at: <http://www.hfip.org/products/>.

2.21 A workshop to address forecasting competencies that were introduced during the WMO HC-35 in Cancun, 2014 was held in Costa Rica during 9 and 10 April 2015. An attempt to have another forecasting competencies workshop during 2016 did not materialize. Another attempt was expected in 2017.

2.22 RSMC Miami partnered with the Cooperative Program for Operational Meteorology, Education, and Training (COMET) to produce several storm surge and hurricane wind-related on-line training modules. These modules were geared toward meteorologists and emergency managers and were freely available at www.meted.ucar.edu.

3. REVIEW OF THE PAST HURRICANE SEASON

3.1 Summary of the past season

3.1.1 Dr Lixion Avila, from RSMC Miami, presented a summary of the 2015 Atlantic and eastern North Pacific hurricane season. In the presentation, Dr Avila mentioned that only Tropical Storm Ana and Tropical Storm Bill made landfall in the United States. Moisture from several tropical cyclones in the eastern North Pacific spread northward causing locally heavy rainfall over portions of the southwestern United States. Most of the rain impact was associated with moisture from Hurricane Linda.

USA reported that tropical cyclone activity in the Atlantic basin during the 2015 season was below average. Of the 11 tropical storms that formed, 4 became hurricanes, and 2 reached major hurricane strength (category 3 or higher on the Saffir-Simpson Hurricane Wind Scale). In comparison, the 1981-2010 averages are 12 tropical storms, 6 hurricanes and 3 major hurricanes. The Accumulated Cyclone Energy (ACE) index, a measure that takes into account the strength, duration, and frequency of the season's tropical storms and hurricanes, was 68% of the long-term median value.

3.1.2 A non-tropical low pressure system formed early on May 6 just offshore of the southeastern coast of Florida and moved slowly northward over the next two days. On May 8, the low was designated a subtropical storm when it was located about 175 miles south southeast of Myrtle Beach, South Carolina. Ana moved slowly north-northwestward over the warm waters of the Gulf Stream on May 8-9 and transitioned to a tropical storm early on May 9 about 130 miles southeast of Myrtle Beach. Ana's intensity remained steady near 60 mph while the cyclone was over the Gulf Stream. However, by late that day, the tropical storm began to weaken as it moved off of the Gulf Stream and over the cooler coastal shelf waters. Ana made landfall around 1000 UTC May 10 just southwest of North Myrtle Beach, South Carolina, with an intensity of 45 mph. The May 10 landfall made Ana the earliest U.S.-landfalling tropical cyclone on record. Ana produced storm surge flooding up to 2.5 feet above normal tide levels along portions of the coasts of South Carolina and North Carolina. Storm-total rainfall of 3 to 6 inches occurred across portions of eastern North Carolina, producing some inland freshwater flooding. Abnormally high tides in combination with Ana's storm surge resulted in minor beach erosion along the coasts of northeastern South Carolina and southeastern North Carolina. Property damage in the U.S. was minor. There was one direct death associated with rip currents off the coast of North Carolina.

3.1.3 Bill formed on June 16 while centered about 200 miles east-southeast of Corpus Christi, Texas and moved northwestward toward the Texas coast. Bill made landfall on Matagorda Island at 1645 UTC June 16 with maximum winds of 60 mph. Later that evening, Bill turned northward and accelerated inland over eastern Texas,

weakening to a tropical depression early on June 17 when centered about 35 miles east of Austin, Texas. The depression continued northward for the next two days, and became a remnant low on June 18 while located about 75 miles south-southeast of Tulsa, Oklahoma. Bill's remnant low moved east-northeastward for the next few days, producing heavy rain, flooding, and tornadoes across southern Missouri, northern Arkansas, and portions of the Ohio River Valley. The low dissipated on June 21 over the mountainous terrain of West Virginia.

Bill produced a storm surge of 3.5 feet just east of its landfall point. Combined with the normal tide, Bill's surge produced inundation of 1 to 3 feet above ground level for parts of the upper Texas and southwestern Louisiana coasts. Heavy rains from Bill also fell from the central Texas coast northeastward across eastern Texas, western Louisiana, and southern and eastern Oklahoma. Many locations reported storm-total amounts in excess of 10 inches with the highest rainfall report being 13.78 inches in Ganado, Texas. The heavy rainfall caused flash floods and flooding of major rivers across portions of Texas and Oklahoma. The Red River at Interstate 35 along the Texas/Oklahoma border reached a record crest of 42.05 feet, 17 feet above flood stage. Farther north, the Washita River near Dickson, Oklahoma, reached a record crest of 48.70 feet, which was more than 21 feet above flood stage. Flash flooding was reported in the Austin and San Antonio metro areas. Property damage in the U.S. was minor.

Bill caused two direct deaths as a result of heavy rain and flooding in Oklahoma during its tropical depression stage. In addition, Bill's precursor disturbance produced heavy rains, flooding, and landslides over portions of Central America and the Yucatan Peninsula of Mexico. In Honduras, two people died in floodwaters near Tegucigalpa, while two other people were reported missing. More than 500 people were affected by floods and landslides in Honduras. Two people died in landslides in Guatemala, with 516,000 people having been affected by flooding and landslides in that country.

3.1.4 Erika moved over the northeastern Caribbean Sea August 28, passing south of the U.S. Virgin Islands and Puerto Rico. Later that day, Hurricane Hunter aircraft observations revealed that Erika no longer had a well-defined center of circulation, and the tropical cyclone dissipated just south of the eastern tip of Hispaniola. However, damage estimated near \$17.4 million occurred in Puerto Rico, mainly due to losses of plantains, bananas, and coffee.

The Commonwealth of Dominica, the nature island of the Caribbean, was impacted by excess rainfall associated with Tropical storm Erika on 27th August. The rainfall was torrential, with measurements in excess of 320 mm (12.6 inches) over the twelve hour period from 0600 1800 UTC which resulted in devastating flooding and landslides. The floods and landslides caused massive infrastructure damage and the loss of 30 -35 lives. The Prime Minister reported that Dominica was set back twenty years as a result of the devastating impact of Tropical storm Erika.

Warning products issued by the Dominica Meteorological Service (DMS) and other integral agencies should consistently be given the necessary attention and actions should be taken by the public to save lives and property. Although significant, less focus should be placed on whether the island was under a tropical storm or

hurricane watch or warning and greater attention should be given to the local hazard that pose an imminent threat to a particular community. Dominica is highly vulnerable to hydro-meteorological hazards. Therefore, one should always be prepared. Every effort should be made by the public to be kept inform of impending severe weather conditions and more importantly to access information from trusted sources and responsible organizations.

The devastation caused by Erika clearly showed that the early warning system for Dominica needs to be strengthened. The Dominica Meteorological Service would need to invest in capacity building, equipment and infrastructure development and community outreach to develop the mitigation measures and resilience needed to survive severe weather events like the rainfall from Erika. The Service also needs to be empowered to provide watches and warning of impending severe weather through the best communication medium and to educate the public to take action when a bulletin is issued.

3.1.5 Joaquin did not make landfall in the United States. However, it is directly responsible for 34 deaths in the waters off the Bahamas and Haiti. Almost all of the deaths occurred when the U.S.-flagged cargo ship El Faro was lost at sea near the Bahamas while Joaquin was moving through the area.

Moisture partially originating from Linda spread northward, causing locally heavy rainfall over portions of the southwestern United States. On 15 September, a strong mid- to upper-level trough and the remnants of Linda moved eastward into southern California producing 2.39 inches of rain in Los Angeles on that day. This was the second-wettest September day since records began in that city in 1877. A rainfall total of 1.15 inches was observed in San Diego that same day, which was also that city's second-wettest September day on record.

Linda and its remnants caused no casualties or damage in the United States. Media reports, however, indicate that 7 hikers died in a narrow canyon in Utah's Zion National Park when it filled with rushing water during the flash flood. That same day, 12 other people, including nine children, died in Hildale, Utah, when two vehicles were swept away in flash flooding. A 6-year old child in one of the vehicles remains missing and is presumed to have perished. The 20 fatalities that occurred in Utah that day made it the deadliest flood event in the state's history. These are not considered direct deaths caused by the tropical cyclone.

3.1.6 The detailed report on the 2015 hurricane season provided by the RSMC is given in **Appendix III**.

3.2 Reports on hurricanes, tropical storms, tropical disturbances and related flooding during 2015

3.2.1 Members provided the Committee with reports on the impact of tropical cyclones and other severe weather events in their respective countries during 2015.

3.2.2 The Members' reports submitted to the current session are given in **Appendix IV**.

3.2.3 The other countries represented at the meeting stated that during the 2015 season they were not significantly or at all impacted by a tropical cyclone.

4. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME

4.1 The Committee was informed by the WMO Secretariat that the 17th WMO Congress endorsed/approved the TCP Programme to arrange and take necessary actions particularly for the following:

- to expand and consolidate further the regionally coordinated systems to cover all Members prone to tropical cyclones;
- to enhance the capacities of Members to provide more accurate forecasting and warning services which are impact-based and in multi-hazard approach (which was also a decision of EC-66);
- to improve forecasting and warning capabilities of Members through advances in sciences and technologies, and capacity development; and
- to reduce damage and loss of lives through the above institutionalized activities and arrangements, and in step with the developmental goals of the Sendai Framework.

4.2 The Committee was informed that TCP activities during the inter-sessional period were mainly focused on following aspects:

- Training and Capacity Development
- Support to Operational Forecasting
- Global and Regional Coordination of Forecasting Services
- Storm Surge Services

4.3 The Committee was informed that the scope of activities of the regional Tropical Cyclone committees had been expanded through involvement with the WMO's cross-cutting projects such as the Severe Weather Forecasting Demonstration Project (SWFDP), Coastal Inundation Forecasting Demonstration Project (CIFDP) and Disaster Risk Reduction projects for Early Warning Systems in Regions I, II, IV and V. The Committees' annual/biennial sessions serve as venues for information sharing for the projects and their technical plans have incorporated collaborative actions with those projects. Wider cross-cutting project coverage was further needed to reach all the Member countries of the regional TC committees. In addition, a synergistic relationship with other UN agencies and international/regional entities has also been developed.

4.4 The Committee was presented by WMO Secretariat about the outcomes and recommendations from the TCM-8 (Miami, Florida, USA, 2-6 November 2015), IBTrACs-III and IWSATC (Both in Honolulu, Hawaii, USA, 16-19 February 2016).

4.5 The Committee discussed how to strengthen the roles of TCM in global coordination on tropical cyclones. The Hurricane Committee does not have enough information to determine how any change in the structure of TCM, presented by

WMO would affect the Committee's functions, since it is a committee of a Regional Association.

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

4.6 Mr Tyrone Sutherland (British Caribbean Territories) served as rapporteur on this agenda item with the assistance of other members of the BCT team.

4.7 The Committee was informed by RSMC Miami of its difficulty in coordinating tropical cyclone watches and warnings for Cabo Verde the Cape Verde National Institute of Meteorology and Geophysics prior to the passage of Hurricane Fred which affected the Cape Verde Islands in 2015. Although Cape Verde is a Member of WMO Regional Association I (Africa), the islands are located the Eastern North Atlantic Ocean, and the RSMC Miami has responsibility for tropical cyclone analysis, tracking and forecasting in the North Atlantic and Eastern North Pacific Oceans.

4.8 The Committee requested that WMO initiate contact with the Permanent Representative of the Republic of Cape Verde to establish a communication pathway between the National Institute of Meteorology and Geophysics and RSMC Miami. Further, it was also decided that the President of RA IV should use his office to liaise with the President of RA I to assist in establishing the communication pathway.

4.9 It was noted that the Republic of Cape Verde has attended a meeting of the Hurricane Committee in the past as an observer. The Committee requested that the WMO Secretariat continue to invite Cape Verde to future meetings and to participate in the Hurricane Forecasting Course, which is held at RSMC Miami in English and Spanish.

4.10 Dr Albert Martis (Chair, RA IV Task Team on Disaster Risk Reduction) informed the Committee of the Disaster Risk Reduction (DRR) activities to improve the Multi-Hazard Early Warning System (MHEWS) to be undertaken in the Region. A regional workshop would be organized in 2017 to assess the progresses of national MHEWS implementation plans. To further the organization of this workshop, a survey was disseminated Member States which would identify gaps in competencies and the need for capacity development. The Committee was informed that it is essential to introduce standardized operational procedures, color warning schemes, and disaster assessments. The committee will need to address the challenges between the effectiveness of color schemes in each country versus the desire for consistency between countries.

4.11 Dr Martis indicated that national implementation plans must identify the hazards, the impacts and vulnerability. Further, it would identify the means of monitoring, models and the standard operating practices on the issuance of alerts, watches and warnings and the means of communication to inform the general public and specialized users. It was noted that if Common Alerting Protocol (CAP) was used, the same message would be broadcast across different communication media, including national press agencies.

4.12 The Committee noted that at the community level, the national implementation plans must include evacuation emergency routes, capacity building, community outreach, disaster investigation and assessment. The committee agreed that prior to the next Hurricane Committee a short workshop to include meteorologists and disaster managers will be held to address the best practices regarding the means of communication with the disaster management organizations. Potential funding for this activity is described in section 8.

4.13 The Committee was informed that, effective from the 2016 Hurricane season, The Netherlands would be issuing watches and warnings for Bonaire, Saba and St. Eustatius. The Committee requested that official correspondence be sent to the President of RA IV informing of the new paradigm for the issue of watches and warnings for these islands.

5. REVIEW OF THE RA IV HURRICANE OPERATIONAL PLAN

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

5.2 As one of its first activities, the Hurricane Committee formulated the RA IV Hurricane Operational Plan to define the responsibilities of all the Members concerned to ensure the most effective coordination and cooperation between those Members in the provision of meteorological information, forecasts and warnings of all tropical cyclones affecting the area. It has also served as a valuable source of information for hurricane forecasters in the region and other users, particularly under operational conditions.

5.3 The Operational Plan was published by WMO as a WMO-No. 1163 (in 2015). RA IV, at its sixteenth session (Willemstad, Curacao, April 2013), decided to keep in force Resolution 14 (IX-RA IV) and thus to maintain the status of the Plan. Changes to the Plan were made at the Thirty-seventh session of the Committee, and approved by the President of RA IV. To facilitate the work of the session, the 2015 edition of the Plan (with RSMC proposed changes for 2016) is attached to this document as **Appendix V**.

5.4 The Operational Plan defines the sharing of responsibilities among the Members for various segments of the system and records the high level of regional cooperation and coordination achieved. In particular, it records the agreed arrangements including, amongst others, those for standardization of operational procedures, provision and efficient exchange of various data related to hurricane warnings and issue of tropical cyclone advisories, and other products from a central location, i.e. RSMC Miami - Hurricane Centre with activity specialization in tropical cyclone analysis, tracking and forecasting, which has the required facilities for this purpose.

5.5 The committee request that Haiti officially confirms that the country is able to undertake the responsibility for issuing tropical cyclones watches and warnings for inland Haiti and its coastal waters. The committee also recommends that USA should still be the back-up, if agreed by the Member.

5.6 In reviewing the Operational Plan, it was proposed to take into account the important role of the RSMC Miami - Hurricane Centre in the operational forecasting services in the region and the discussions under the agenda items 3 and 4.1, i.e. "Review of the past hurricane season (2015)" and "Coordination in operational aspects of the hurricane warning system and related matters", respectively.

5.7 During the review, the Committee voted to remove *Erika* and *Joaquin* from the list of named Atlantic tropical cyclones and *Patricia* in the Eastern North Pacific Ocean name list. *Elsa* would replace Erika, *Julian* would replace Joaquin and *Pamela* would replace Patricia respectively.

6. REVIEW OF THE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2016 AND BEYOND

6.1 The Committee requested the Members to provide inputs, if any, as soon as possible, if they did not do so, when Mr Oscar Arango sent the Technical Plan for revision in February.

6.2 The Hydrological Report to the Hurricane Committee provided information on the developments and progress made in the field of hydrology in RA IV. The Committee was informed of the significant progress made in the implementation of the RA IV priority hydrological activities in the following areas: capacity-building; hydrological data and networks; flood risk analysis, management, prediction, forecasting and warning; drought risk analysis, management, prediction, forecasting and warning; the use of the results of regional climate models in the evaluation and management of water resources, and the evaluation and feasibility of regional projects. The Central American Hydrology Forum (Foro Hidrológico de América Central (FHAC)) was re-established under the auspices of WMO, the Central American Committee for Water Resources (Comité Centroamericano de Recursos Hídricos) and GWP. The Virtual Hydrology Forum was strengthened as a working tool. There was notable progress in the implementation of the Flood Forecasting Initiative, with the promotion of national and regional projects to help achieve its objectives, while considerable progress continued to be made in the development and implementation of the Flash Flood Guidance System, particularly in all the Central American countries, Haiti and the Dominican Republic. Efforts were made to establish closer links between the Severe Weather Forecasting Demonstration Project and the Flash Flood Guidance System in order to build capacity for predicting floods of this kind.

6.3 The Committee recommended to the President of RA IV that the updated RA IV Hurricane Committee's Technical Plan and its Implementation Programme (see **Appendix VII**) be approved.

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

7.1 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- fifth session and considered the plan for future action.

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), has continued the development of technical cooperation activities to ensure cost-effective services to Members. The NCAC Office has also provided support to regional activities and assisted in the implementation of WMO Programmes in the Region.

Regional Activities

7.2 During 2015, and within the context of the agreement between the WMO and Government of Mexico, WMO continued providing assistance to support the National Water Commission (CONAGUA) in the execution of PREMIA (Strengthening Integrated Water Management in Mexico) and MOMET (Modernization of the NMS of Mexico) projects.

7.3 As to the PREMIA project, WMO through its Project Office in Mexico in coordination with CLW Department (and with the support from the Technical Support Unit of the APFM and IDMP) provided assistance in relation to the development of the Mexican national programmes for drought and flood. In this sense, a follow-up and training workshop was organized and carried out with the participation of the different regional offices of the CONAGUA. The translation into Spanish of the Manual on Flood Forecasting and Warning (WMO No. 1072) is being carried out within the framework of this Project and its finalization is expected for the first semester of 2016, in time for its use in the training activities to be organized in the framework of the CIMHET.

7.4 In relation to the MOMET project, WMO has continued providing assistance for its execution, as outlined in the Strategic Development Plan 2012-2018 for the NMS of Mexico. Within the context of this year work plan, several training and education activities are foreseen. Some of them will be executed with support of the RMTC's in Costa Rica (AR-IV) and Argentina (AR-III), as well as through horizontal cooperation with AEMET.

7.5 The Directors of Iberoamerican NMHSs continued to support activities in RA III and RA IV with the implementation of its action plan for the period 2014-2017. The main lines of action of the three-year plan include, 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 prevention and monitoring of extreme events.

Training

7.6 The RA IV Workshop on Hurricane Forecasting and Public Weather Services took place in Miami, U.S.A, from 29 February to 11 March 2016. This very important workshop is organized on an annual basis at the National Hurricane Centre in Miami, USA, with strong support of WMO and the U.S.A.

7.7 WMO, through the trust fund from Spain, continued to support during 2015, 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. Several countries in RA IV have already benefited from the open source MCH database provided by the Conference.

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

Assistance to NMHS

7.9 The "Haiti Weather Systems Programme – Climate Services to Reduce Vulnerability in Haiti" project continues to be implemented. The five years project aims to develop the capacity of the National Meteorological and Hydrological Services (NMHS) of Haiti to deliver Early Warnings and also general weather, climate and hydrology services to the people of Haiti. The main aspects of the project include up now the activities listed below:

- The Ministry of Agriculture, Natural Resources and Rural Development to which the meteorological and hydrological services belong, proceeded to the unification of both services and the creation of the Hydrometeorological Unit (UHM). This initiative is supported by the Project with the definition of the organigram, its mission, objectives and posts, as well as a proposal to assign the existing human resources in view of the new organigram.
- During the period 2015-2016, with the support of UNOPS, the phase of the design of the seismic and cyclone resistant building will be finalized, which will become the future hydrometeorological service of Haiti (UHM). It is foreseen to start construction in April 2016.
- With regards to training, an education plan is written and an important number (14) of training actions have been carried out (FFGS, climatology, instrument calibration, marine meteorology, direction and management of NMHS). Training on aeronautical assistance and hydrology are scheduled in May 2016. Meteorologists from Haiti also attended international meetings in which around 60 people participated. Some of these actions are carried out with the support of Meteo France.
- The observation network is being improved with 2 AWS already installed in Port au Prince (with back up) and Cap Haitien. The installation of 3 more is scheduled in the second half of 2016(Jacmel, Les Cayes and Jeremie) along with a data collection system via telemetry. This action has been supported by INSMET Cuba.

7.10 The Agency for International Cooperation from Spain (AECID), with funds provided by the European Union and with the Spanish Meteorological Agency (AEMET) as implementing institution, has secured funds for the installation of a lightning detection network in Central America. Discussions are currently under way

to design the network and advance with required agreements with participating countries.

7.11 Assistance was provided to Honduras by AEMET and WMO with regards to the reorganization of the meteorological and hydrological activities in this country. A first report has already been submitted to the local authorities and discussions with high level authorities are expected in the near future.

VCP Projects

7.12 During 2015, WMO continued providing assistance to NMHSs through the VCP Programme. One request was supported in the region, benefiting Dominica (emergency request). It should be noted that donations to the VCP have continuously decreased during the last years. During the period 2014-2015, only USD 85000.00 was received to cover global needs. A list of VCP projects carried out for 2010 through 2015 related to the Members of RA III and IV is given in **Appendix VIII**.

8. OTHER MATTERS

Update of Storm Surge demonstration project

8.1 Dr Jamie Rhomie updated the Storm Surge Demonstration Project (NHC) mentioned partners and contributors, in particular NOAA, USAID, FIU and WMO. The speaker briefly introduced CIFDP-C principal scientists and explained the need for a demonstration project (over 80% of deaths are due to water, among other reasons).

The Caribbean Demonstration Project started in the Dominican Republic and in 2014 the project was re-scoped into a Caribbean-wide demonstration project. The Caribbean project has now a regional perspective.

Dr Rhomie explained the different phases of the project and the CIFDP-C Project Kickoff and NCT Meeting. In order to hear from other countries, with WMO funding, a highly technical and practical workshop was held in NHC in 2015, after which participants were asked to give feedback.

Mexico Storm Surge Demonstration Project has an initial scoping project in Yucatan Peninsula. After explaining the phases of the Project, Dr Rhomie introduced the NOAA ETOP1 and the Shuttle Radar Topography Mission. It is necessary to have homogenous and good quality data to have a good modelling result.

Mr Rhomie exposed the TanDEM-X German satellite, whose dataset has global coverage and accuracy is substantially improved. The initial assessment is very encouraging for the Caribbean, the topography QA/QC is essential and the bathymetric data is already built-in the project.

As per the modeling, leveraging US modeling testbed for Puerto Rico and the Virgin Islands broke down the cost and it was recommended that the existing modeling systems are too expensive (2nd generation wave model for SLOSH significantly

reduce costs). Dr Rhomie showed the initial results of wave modeling and the Hispaniola Demonstration Project SLOSH grid. The model coupling and validation will help ensure that the model is producing the expected results.

Maximum of the MEOws (MOMs) helps composite results to give instantaneous results immediately; it is much more applicable for Caribbean countries.

Dr Rhomie added that COMET modules have been translated into Spanish and French and video material for general public has been prepared in Spanish to increase awareness among population.

Dr Rhomie thanked the NHC's Storm Surge Unit for its work.

Watches and warnings before formation

8.2 Mr Daniel Brown of RSMC Miami gave a presentation on new and future NHC products and services. He mentioned the real-time NHC Storm Surge Products, which included the Potential Storm Surge Flooding Map that would become operational this year. The map would be issued for areas along the Gulf and Atlantic coasts of the United States and show the height, above ground level, that storm surge inundation could reach.

It was indicated, that after Erika there was a need for enhanced messaging, RSMC added key messages to the NHC Tropical Cyclone Discussion during hurricanes Joaquin and Patricia.

NHC would continue to add key messages to the discussion and share them through social media during high-impact events or when there is unusually large forecast uncertainty.

NHC would sometimes issue special messages on its website and Twitter feed to inform users of its intentions of starting advisories on a system.

Mr Brown reported that NHC was working on a Time of Arrival of Graphic, which would provide onset times for tropical-storm-force winds. This graphic could debut as an experimental product in 2017.

NHC continued to work in developing the capability to issue tropical storm and hurricane watches and warnings before tropical cyclone formation. This capability was expected to debut during the 2017 hurricane season. The concept was to broaden the definitions of the watches and warnings to use them for potential tropical cyclones (disturbances with significant risk of becoming a tropical cyclone and impacting land within the watch/warning time period).

The naming and numbering system for potential tropical cyclones would be similar to the system used for tropical depressions. The typical NHC advisories products would be produced for potential tropical cyclones requiring watches or warnings, including the public advisory, forecast advisory, discussion, wind speed probabilities and associated graphics.

No changes were required to the 2016 Operational Plan, but changes would be needed in 2017 to reflect this expected capability.

Mr Brown concluded the discussion by mentioning new tropical-cyclone-related COMET training modules that were available on-line at www.meted.ucar.edu and the new Florida International University Spanish-language hurricane website (<https://huracanes.fiu.edu/>).

TAFB products

8.3 Dr Richard Knabb presented the RSMC Miami Tropical Analysis and Forecast Branch products and highlighted the unit forecast duties as well as the staffing used during the busy peaks of the hurricane season. These products include the Dvorak classifications which were important during the hurricane forecasting process.

The Committee was informed about the Unified Surface Analysis as well as the Tropical Weather Discussion (TWD) TAFB areas of responsibility. Dr Knabb also summarized the recent TAFB product changes over the years and emphasized that the Offshore Waters Forecasts was now providing more detailed information.

The use of TAFB National Digital Forecast Database (NDFD) Gridded Marine Forecasts was explained. Dr Knabb ended his presentation with the TAFB plan for 2016-2019. RSMC Miami requests feedback on TAFB marine products from the members.

GEOS-R (NASA/NESDIS)

8.4 Ms Sandra Cauffman's presentation covered a background of the GOES-R program, covering all aspects of the improved flight and ground systems. It covered all the expected changes that the users need to make in order to access future GOES-R data and products. It had many examples of proxy derived products for the ABI and GLM instruments that demonstrate the significant improvement the user would be able to obtain from GOES-R. There will be a need to replace ground equipment to receive the data. She highlighted the need to replace the existing ground equipment to obtain data generated by the new satellite series.

ICG Tsunamis in the Caribbean

8.5 Ms Christa G. von Hillebrandt Andrade, Chair of Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS) and Manager of the NWS Caribbean Tsunami Warning Program, provided updates on services, products and activities of the CARIBE EWS.

She thanked the WMO RA IV Hurricane Committee for providing this update as many Hydrometeorological offices are key stakeholders within the system. It was recalled that although not as frequent as other events, like Hhurricanes, tsunamis present a high hazard and risk to the region.

The UNESCO IOC established the CARIBE EWS to coordinate the tsunami services and activities in the region in 2005 with 32 participating Member States and 6 Territories. All, but one, have identified Tsunami Warning Focal Points and Tsunami National Contacts, fewer have identified National Tsunami Warning Centers and Tsunami Advisors.

The most recent meeting was held April 5-7, 2016 in Cartagena, Colombia. In 2015 the CARIBE EWS adopted a new Tsunami Service Model, clarifying the roles and responsibilities of stakeholders and the products to be issued by the Tsunami Service Providers.

It was recommended that the Pacific Tsunami Warning Center (PTWC) be referred to as a CARIBE-EWS Tsunami Service Provider (TSP), removing the term "Interim". This recommendation was based on PTWC meeting the criteria established in the CARIBE-EWS Tsunami Service Model, and successful operational performance in support of CARIBE-EWS in a TSP role since 2005 and the successful implementation of the Enhanced Tsunami Products in March 1, 2016.

She recalled that each country/jurisdiction was now responsible for establishing alert level (warning, advisory, watch, etc.), disseminating the products and issuing the Cancellation and All Clear. She highlighted the results of the CARIBE WAVE16 exercise that mobilized over 331,000 people on 17 March 2016. She indicated that the next exercise was to be conducted on 21 March 2017.

She also reported on preparedness and awareness activities in the region including the implementation of the Tsunami Ready recognition program and the status of the Caribbean Tsunami Information Center (CTIC). She highlighted that the Caribbean Tsunami Information Center's core financial resources were still to be found, but the Executive Secretary IOC had been able to identify extra budgetary and regular programme funds to sustain CTIC's operations.

Severe Weather Forecast Demonstration Project (SWFDP)

8.6 The Hurricane Committee was charged by the RA IV Management Group to undertake a wide-ranging discussion on the concept of developing a WMO Severe Weather Forecast Demonstration Project (SWFDP) for the southern portions of RA IV, in order to provide it with expert opinions to guide its future decisions on the matter. This discussion by the Hurricane Committee was led by Mr Tyrone Sutherland of the BCT, a member of the RA IV Management Group, supported by Mr Jean-Noel Degrace of France. The Management Group discussed this matter at its sessions in May-June 2015 and in January 2016, based on the introductory extract from a CBS document on SWFDP given in **Appendix VI** to this Report.

8.7 In particular, the Hurricane Committee noted the following recommended goals of a SWFDP:

- to improve the ability of NMCs to forecast severe weather events;
- to improve the lead time of alerting of these events;
- to improve interaction of NMCs with Disaster Management and Civil Protection Authorities (DMCPA) before and during events;
- to identify gaps and areas for improvements;

- to improve the skill of products from GDPFS Centres through feedback from NMCs.

8.8 In this regard, the Committee was informed of the Management Group's strong opinion that within a SWFDP, RA IV was "**not starting from zero**" in providing guidance in terms of severe weather. The Region had a very well organized and effective warning system for tropical cyclones, in which the RA IV Hurricane Operational Plan was reviewed by regional experts annually. The Hurricane Committee agreed with the view of the Management Group that, on occasions, weaknesses in the warning systems in the region did show up when severe weather occurred that was not related to tropical cyclones or when localized weather on the fringes of tropical cyclones resulted in significant damage or loss of life.

The discussions therefore focussed on the view that in such situations, Member States could benefit from improved forecast and warning coordination and advice that could be provided by a sub-regional operational facility. It was pointed out that even in situations when tropical cyclones were not involved, the RSMC in Miami could still play a guidance/consultative role with this sub-regional operational facility.

8.9 The Committee was informed that the Region was looking towards a sustainable long-term operational mechanism, whether it was called a Regional Forecast Support Centre (RFSC) or otherwise, that could have its genesis in a SWFDP. The discussions therefore surrounded the concept that a SWFDP focussing on the Eastern Caribbean islands, in the first instance, could utilize the facilities of Météo-France in Martinique as this sub-regional operational facility, in order to undertake such forecast coordination among Meteorological Services. It noted that Météo-France had already agreed to undertake this role if so decided by the Region.

The Hurricane Committee stressed very clearly that, at no time could the formal coordination role of the RSMC-Miami in the case of tropical cyclone-related weather be compromised or undermined by arrangements emanating out of the SWFDP.

8.10 The Hurricane Committee agreed, in principle, to the following, which would be recommended to the RA IV Management Group for its further deliberation:

- (a) The SWFDP in RA IV would cover the islands from Trinidad in the south to Puerto Rico in the North;
- (b) the full membership of the RA IV SWFDP Expert Group would be:
 - (i) *Mr Tyrone Sutherland* (BCT);
 - (ii) *Dr Albert Martis* (Curaçao);
 - (iii) *Mr Keithley Meade* (Antigua & Barbuda);
 - (iv) *Mr Jean-Noel Degrace* (Martinique, France);
 - (v) *Dr Lixion Avila* (RSMC Miami); and
 - (vi) a representative of Canada (to be named); and
 - (vii) *Ms Kathy-Ann Caesar* (CIMH).

- (c) The Expert Group would draft, in collaboration with the WMO Secretariat, the Terms of Reference of a Regional Forecast Support Centre (RFSC), including recommendations for its interaction with and support from RSMC-Miami;
- (v) The Caribbean Institute for Meteorology and Hydrology (CIMH) should have a key role in providing input to and technical support for the SWFDP.

CIMH's model run results/Hurricane Joaquin and Tropical Storm Erika

8.11 Ms Kathy-Ann Ceasar made a presentation to the Hurricane Committee and reported that Tropical Storm Erika and Hurricane Joaquin were among the most devastating Tropical Cyclones to affect the Caribbean in a decade, results in over 40 deaths and millions of dollars in damage.

One of the key achievements of the Enhancing Resilience to Reduce Vulnerability in the Caribbean – ERC Project (2009-2013)¹ has been the deployment of the DEWETRA platform for the CARICOM area, now managed and operated by the Caribbean Institute for Meteorology and Hydrology (CIMH). One of the key assets on the platform are the WRF-ARW mesoscale NWP products. CIMH operates the WRF-ARW model over the entire Caribbean region, with twice daily uploads to of WRF-ARW products on the DEWETRA platform. The WRF runs are initialized by data from the Global Forecast System (GFS) model for 0000Z and 1200Z during the hurricane season and 0000Z otherwise. This presentation focused on the CIMH WRF model runs for TS Erika and Hurricane Joaquin, and highlights the successes of the 4 km nested model.

For TS Erika the WRF-ARW model produced a quantitative precipitation forecast (QPF) which mirrored the observed localized rainfall experienced as the storm affected the island of Dominica.

In the case of Hurricane Joaquin it was an interesting result which confirmed the WRF-ARW outputs were capable of “correctly” predicting the storm track as it headed towards the open Atlantic Ocean. The reason for the success appears to be in the use of the nested grid process and the high resolution of the model.

CIMH would continue to experiment with these approaches and intended to increase its efforts to improve on these products for the betterment of the Region.

Upper Air Status of the Cooperative Hurricane Upper Air Stations (CHUAS) Network in the Caribbean

8.12 Mr Hiram Escabi, the Upper Air Program Manager for the United States National Weather Service (NWS), provided a presentation concerning the Cooperative Hurricane Upper Air Stations (CHUAS) network for the Caribbean. This presentation provided information concerning network background, history, stations, certified upper air observers, maintenance, station inspection, station report,

¹ ERC

Project(http://www.bb.undp.org/content/barbados/en/home/operations/projects/crisis_prevention_and_recovery/erc.html)

radiosonde soundings, new ground system, radiosondes, equipment upgrade, status of equipment upgrade, GRAW systems installed and future goals of CHUAS radiosonde soundings.

8.13 The main discussion during the presentation was the presentation radiosonde GPS issue, the GPS module, the standardized temperature profile, balloons, the consumable costs of radiosondes, the equipment upgrade and the timeliness.

Forecaster Competencies

8.14 Mr Keithley Meade of the Antigua & Barbuda Meteorological Services provided an update on the development of Hurricane Forecaster Competencies within RA IV. Mr Meade encouraged greater 'buy-in' by NHMs within RAIV and asked for further guidance and feedback. He further indicated his desire to see RTCs explore ways to incorporate elements of the competencies within training courses and to see the competencies more aligned with existing competencies. The Committee will seek funding for a workshop that could involve meteorologists and disaster managers to be held in Costa Rica in 2017.

9. SCIENTIFIC LECTURES

Participants were invited to attend the last two days of AMS Conference (21-22 April), focusing on topics on hurricanes and tropical meteorology, as part on Scientific Lectures of the HC-38. US provided funding through WMO VCP to those participants who were funded by WMO for their participation in the AMS Conference.

10. DATE AND PLACE OF THE THIRTY-NINTH SESSION

The Committee was informed that Costa Rica would consider hosting the thirty-ninth session of the RA IV Hurricane Committee 23-26 March 2017. The details on the venue will be determined and communicated to the Committee members later. France offered to host the fortieth session of the RA IV Hurricane Committee in 2018.

11. CLOSURE OF THE SESSION

The report of the thirty-eighth session of the Committee was adopted by the Committee and approved by the President of RA IV. The meeting ended at 12:00 pm on 26 April 2016.

LIST OF APPENDICES

- Appendix I** List of Participants
- Appendix II** Agenda
- Appendix III** RSMC Miami - 2015 North Atlantic and Eastern North Pacific Hurricane Season Summary
- Appendix IV** 2015 Hurricane Season Reports (Submitted by Members of the RA IV Hurricane Committee)
- Appendix V** The 2015 edition of the Plan (with RSMC proposed changes for 2016)
- Appendix VI** Severe Weather Forecasting Demonstration Project. The overall Project Plan
- Appendix VII** RA IV Hurricane Committee's Technical Plan and its Implementation Programme
- Appendix VIII** List of VCP projects related to WMO Members from RA III and RA IV for the years 2010 to 2015

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Appendix I

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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. REVIEW OF THE PAST HURRICANE SEASON
 - 3.1 Summary of the past season
 - 3.2 Reports of hurricanes, tropical storms, tropical disturbances and related flooding during 2015
 4. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME
 - 4.1 COORDINATION IN OPERATIONAL ASPECTS OF THE HURRICANE WARNING SYSTEM AND RELATED MATTERS
 - 4.2 REPORT OF THE OUTCOME AND RECCOMENDATIONS OF TCM-8
 5. REVIEW OF THE RA IV HURRICANE OPERATIONAL PLAN
 6. REVIEW OF THE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME FOR 2016 AND BEYOND
 7. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE COMMITTEE'S TECHNICAL PLAN AND STRENGTHENING OF THE OPERATIONAL PLAN
 8. OTHER MATTERS
 9. SCIENTIFIC LECTURES AND DISCUSSIONS
 10. DATE AND PLACE OF THE THIRTY-NINTH SESSION
 11. CLOSURE OF THE SESSION
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RSMC Miami - 2015 North Atlantic and Eastern North Pacific Hurricane Season Summary

The detailed report on the 2015 hurricane season provided by the RSMC is available on the website at: <https://www.wmo.int/pages/prog/www/tcp/reports.html>

2015 Hurricane Season Reports (Submitted by Members of the RA IV Hurricane Committee)

The Members' reports submitted to the current session are available on the website at: <https://www.wmo.int/pages/prog/www/tcp/reports.html>

The 2015 edition of the Plan (with RSMC proposed changes for 2016)

The 2015 edition of the Plan (with RSMC proposed changes for 2016) is available on the website at: <https://www.wmo.int/pages/prog/www/tcp/reports.html>

SEVERE WEATHER FORECASTING DEMONSTRATION PROJECT THE OVERALL PROJECT PLAN (EXTRACT FROM THE CBS 2010 DOCUMENT)

1. WHY A DEMONSTRATION PROJECT ON SEVERE WEATHER FORECASTING?

1.1 Cooperative Work in the Framework of the GDPFS

1.1.1 The aim of the Severe Weather Forecasting Demonstration Project (SWFDP) is to demonstrate how cooperative work among meteorological centres can be further implemented in order to enhance the forecasting process of several types of severe weather phenomena, which in turn would improve the warning services provided by the NMHSs.

1.1.2 The Global Data Processing and Forecasting System's (GDPFS) organization is a three-level system which carries out various functions at the global, regional and national levels. The GDPFS is an underpinning feature for weather forecasts and warning services in all WMO Members. In addition to this organization, several GDPFS Centres are officially entrusted with the responsibility of providing NMHSs with specialized products (i.e. for medium range forecasting, tracking and forecasting tropical cyclones, and long range transport of radiological pollutants in emergency response). Nevertheless, for severe weather events which can cause many casualties and damage, enhancing the exchange and use of existing products or readily adaptable products among GDPFS centres with some NHMSs is desirable.

1.2 Introducing new products and training

1.2.1 During the last decade the skill of Numerical Weather Prediction (NWP) models has continuously improved for all forecast ranges and the technique used in the Ensemble Prediction System (EPS) stands out as an efficient way to provide the forecaster with alternative scenarios or probabilistic forecasts. Initially designed for medium range global forecasting, this technique is also an efficient way to take into account the various sources of forecast errors (initial state, boundary conditions, model) even for short range and for limited area forecasting.

1.2.2 Owing to the high computational cost of the EPS technique implying multiple model runs, only a limited number of GDPFS centres are able to operationally implement such systems. Moreover, with respect to severe weather forecasting, several GDPFS centres provide the forecaster with elaborated products such as maps of potential vorticity, convection indices, etc. A SWFDP will provide the opportunity to encourage operational forecasters to utilize and experiment with standard or newly developed products and procedures, which have already been introduced in GDPFS centres and which could be relevant to a number of NMHSs that have not yet used or applied them.

1.2.3 Despite the increasing number of GDPFS centres that run limited area NWP models, not all forecasters benefit from the recent progress of the NWP techniques or from the training necessary to efficiently use the large numbers of products available from GDPFS centres.

1.3 The context of the THORPEX research and development programme

1.3.1 The Fourteenth World Meteorological Congress launched in 2003 a 10-year international research and development programme called THORPEX (The Observing System Research and Predictability Experiment) to accelerate improvements in the accuracy of one-day to two-week high impact weather forecasts.

1.3.2 This programme, which aims to improve the skill of the weather forecasts especially for the case of high impact weather events by taking advantage of the probabilistic forecasts, will experiment with new techniques and products. In this context, the implementation of regional severe weather forecasting demonstration projects offers a real opportunity to prepare many NMHSs and all GDPFS centres to implement and benefit from the outcomes of the THORPEX research and development programme.

2. THE GOALS OF THE SWFDP

2.1 According to the recommendations of the CBSXIII (2005), the goals of the SWFDP are the following:

- to improve the ability of NMCs to forecast severe weather events;
- to improve the lead time of alerting of these events;
- to improve interaction of NMCs with Disaster Management and Civil Protection Authorities (DMCPA) before and during events;
- to identify gaps and areas for improvements;
- to improve the skill of products from GDPFS Centres through feedback from NMCs.

2.2 The CBS-Ext. (06) stressed the need to work with civil protection authorities and media organizations to improve delivery of severe weather warning services to end users. Subsequently, the Public Weather Services (PWS) and DRR aspects have been integrated into the SWFDP.

RA IV Hurricane Committee's Technical Plan and its Implementation Programme

The RA IV Hurricane Committee's Technical Plan and its Implementation Programme is available on the website at:

<https://www.wmo.int/pages/prog/www/tcp/reports.html>

**LIST OF VCP PROJECTS RELATED TO WMO MEMBERS FROM RA III
AND RA IV FOR THE YEARS 2010 TO 2014**

Country	Title / Focus	Support	Year of Request	Completed
Dominica	Emergency Assistance – Equipment for Main Airport	USAID	2015	2016
Belize	Purchase of Upgrade to the METLAB data acquisition/ display platform	VCP (F)	2013	2014
Colombia	Implementation of a quality management system for the provision of meteorological services for aviation: diagnosis and recommendations for improvement and strengthening.	VCP(F)	2011	2011
Costa Rica	Expense travel to Maryland, USA to participate in the 4 month fellowship at the Tropical Desk of the National Centres for Environmental Prediction.	VCP(F)	2010	2010
Costa Rica	Provision of travel and per diem for participant travel to the "2011 Satellite Direct Readout Conference: Real-Time access to Real Time Applications.	VCP(F)	2011	2011
Guyana	Expert assistance to develop long term strategic plan for hydrometeorological Service in Guyana	VCP (F)	2013	2014
Guyana	Expert from RTC Brasilia or Argentina to implement the new RAIII VPN telecommunications network	VCP (F)	2013	Ongoing
Cuba	Upgrading of 4 INSMET Global Climate Observing System (GCOS) meteorological stations. Replacing meteorological instruments with many years of operation and resuming the programme measurement of key parameters. Stations Cape weather are San Antonio (78,310), White House (78325), Camagüey (78	VCP(F)	2008	2010

Appendix VIII

Country	Title / Focus	Support	Year of Request	Completed
	355) and Maisi (78369).			
Haiti	Meteorological and Hydrological Observing System Infrastructure and Spare Parts Expert services for Procurement and Installations.	VCP(F)	2012	2012
Paraguay	Expert services – Strengthening National Hydrological Services in Paraguay	VCP (F)	2013	2014
Bi-lateral Support				
Country	Title / Focus	Support	Year of Request	Completed
Argentina, Colombia Costa Rica, Cuba. Dominican Republic, Ecuador, Honduras Panama, Paraguay Peru, Uruguay	Provision of 53 mercurial barometers	Germany	2011	2013
Dominica	An audiovisual media Center for the dissemination of meteorological Information to users and the general public.	UK & VCP(F)	2010	2014
Saint Lucia	Refurbishing and Upgrading of AWS network	UK & VCP(F)	2009	2011
