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**The Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)
ANNUAL REPORT 2016**

(Item 5.4.1 of Tentative Program for 49th TC Session)

(Submitted by WGM Chair)

ACTION PROPOSED:

The Committee is invited:

- (a) To take note of the major progress and issues in implementing the project in 2016 as reported
- (b) To encourage TC Members to participate the project and the fellowship research on target typhoon intensity change

The Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)

(WGM of TC)

1. Background (context)

With the significant advances in numerical prediction modeling of typhoon, there has been vital improvement in typhoon track forecast. However, there is no considerable progress in typhoon intensity forecast. In recent decades, the intensity forecasts of numerical prediction models still remain challenging, which may not yet fully meet the need of operation, while operational forecasting of typhoon intensity still mainly relies on statistical methods. In Northwest Pacific region, the core issue that impedes more in-depth analysis and improvements in forecasting capabilities is the lack of observations of structure and intensity changes of tropical cyclones. The primary technique for tropical cyclone intensity analysis widely used by operational forecast centers is the Dvorak technique. The tropical cyclone intensity estimated in warnings may vary across different centers due to the subjectivity of the Dvorak technique. In recent years, though on-board microwave sensors in satellites have gained wide application, they still cannot provide remarkable improvement in this situation.

During the 45th Session of the UNESCAP/WMO Typhoon Committee (TC), held in Hong Kong, China from 29 January to 1 February 2013, the Working Group on Meteorology (WGM) proposed a regional field experiment to be implemented with the cooperation and joint efforts of the TC Members. Similar in scale to the “SPECTRUM-90” Typhoon Research Experiment, this experiment focuses on resolving the difficulties of operational typhoon forecasting and identifying the key scientific issues of tropical cyclone-related disaster prevention and mitigation. The proposed project's concept was well received by TC Members.

Soon after the 45th Session, the WGM drafted the project proposal (first draft). In March 2013, former TC Chair JIAO Meiyan (Deputy Administrator of CMA), at the request of the current TC Chair, organized a thematic symposium with the participation of the WGM Chair and the WMO/WGTMR Chair (DUAN Yihong, President of Chinese Academy of

Meteorological Sciences). The proposal (first draft) was then submitted to TRCG Chair (AWG member) for feedback. Based on discussions during the symposium and recommendations from the AWG, the proposal was then revised and submitted for discussion at the AWG Meeting in Bangkok on May 10, 2013.

Based on the input from AWG meeting, WGDRR and WGH workshop in 2013, the proposal was amended and submitted for discussion at the 8th IWS in Macao, China on December 2-7, 2013. Based on the proposed amendments at the WGM parallel meeting during 8th IWS and the input from Japan Meteorology Agency (JMA) and Hong Kong Observatory (HKO) after the meeting, the proposal was then modified for the fourth time, and was endorsed in the 46th Session of ESCAP/WMO Typhoon Committee in Bangkok, Thailand on February 10-13, 2014.

2. The major progress

2.1 2014 (after 46th Session)

The Organizing Committee (OC) Meeting, which planned to be held in June 2014, was not able to be realized due to the time conflict of the OC Members with their own commitments during the typhoon season. Nevertheless, the field campaign was conducted by CMA and HKO in 2014, which including:

- The reconnaissance flights were conducted by HKO, in collaboration with the Hong Kong Government Flying Service (GFS), to collect meteorological observations (wind) for tropical cyclones over the South China Sea.
- The contract for the supply of a drop-sonde system to be installed on the new GFS fixed-wing aircraft for obtaining vertical atmospheric profiles was signed in 2014.
- The mobile GPS radio-sondes was conducted by STI/CMA to collect vertical atmospheric profiles for typhoon landfalling in East China region.
- The satellite buoy array (including 5 buoys) established successfully in South China Sea. Two tropical cyclones (Rammasun and Kalmaegi) path over the buoy array in 2014, the essential atmospheric and oceanic parameters under typhoon conditions (including the air-sea flux) obtained.
- The technique of rocket sounding developed by CMA as well as the unmanned aerial

vehicle (UAV) in 2014.

The following research project related to the EXOTICCA, on the air-sea interaction and its influence on tropical cyclone intensity change (national basic research programme) and the High Resolution Model (WGM-PP) were carried out by CMA in 2014 and beyond.

The progress on EXOTICCA in 2014 was noted by the 3rd joint session of TC and PTC (include 47th Session of Typhoon Committee and 42th Session of Panel on Tropical Cyclones) in Bangkok, Thailand on February 9-13, 2015.

2.2 2015(after 47th Session)

According to the 47th Session, the first Organizing Committee Meeting for EXOTICCA was held in Shanghai Meteorological Service in Shanghai, China on 9 October 2015. There were 15 experts from China, Hong Kong, China, Japan and United States in the Meeting. The Terms of Reference, Scientific Steering Committee Start-Up Scheme and Research Groups Start-Up Scheme as well as the Project Understanding were discussed with the following highlights:

- A project office (actual or virtual) should be set up and attached to TCS for leading and coordinating with the project;
- Participation of the project should be open to all Members, invited by the OC;
- A Member can participate in both operational and/or research areas in the project;
- A Member can write to the OC to express interest;
- All members are eligible to nominate typhoon experts to form the Scientific Steering Committee, no matter the Member is participating in the project or not;
- Participating Members are encouraged to share the information and/or research results to other Members but there is no obligation to do so.

Technical presentations about the latest technologies and experiments were delivered by STI, HKO and NRL. Two field campaigns were carried out by STI in 2015 including UAV Observation for Typhoon Chanhom in July and Rocket Drop-sondes for Typhoon Mujigae in October 2015; and two aircraft reconnaissance flights were conducted by HKO for Typhoon Linfa in July and Typhoon Mujigae in October 2015. The data were proved to be useful for monitoring the intensity change of the TCs as they approached the coast.

The progress the on EXOTICCA in 2015 was noted by the 48th Session of Typhoon

Committee in Honolulu, USA on February 22-25, 2016.

2.3 2016(after 48th Session)

The 2016 kickoff meeting of EXOTICCA-China was held in Beijing on May 31. During this meeting, CMA organized all the participants of China to discuss the details of 2016 field experiment. The topics included experiment chart, scientific objective, experiment area, observation instruments and experiment funding.

According to the 48th Session, a joint workshop/progress meeting with WMO Typhoon Landfall Forecast Demonstration Project (WMO-TLFDP) and Understanding and Prediction of Rainfall Associated with LandFalling Tropical cyclones (UPDRAFT) was held in Shanghai, China during 20-21 October 2016. More than 40 participants from WMO, Naval Postgraduate School of USA, NOAA, PAGASA, Bureau of Meteorology of Australia, Hong Kong Observatory, National Institute of Meteorological Sciences of Korea Meteorological Administration, Indian Meteorological Society, City University of Hong Kong, Seoul National University, CAMS, Nanjing University, National Meteorological Center of CMA, STI attended the meeting. This meeting promotes the mutual exchange of the latest progress in tropical cyclone research and also enhances international cooperation on tropical cyclone forecasting techniques. EXOTICCA scientists introduced the typhoon field experiment in 2016 and showed some preliminary cooperation research results between STI and HKO with the following highlights:

- STI carried out the field campaign on 3 target typhoons – Nepartak(1601), Meranti (1614) and Megi (1617) in East China coastal area together with Zhejiang and Fujian Meteorology Service, and 1 target typhoon - Sarika (1621) in South China coastal area together with Hainan Meteorology Service.
- HKO conducted reconnaissance flights over the South China Sea in 2016 for a monsoon depression on 26 May, tropical depression on 26 July, Typhoon Nida (1604) on 1 Aug, a low-pressure area on 16 Aug and Tropical Storm Dianmu (1608) on 18 Aug. Trial of the new drop-sonde measurement system using a new jet aircraft was conducted for Typhoon Megi on 27 Sept 2016.
- In coordination with HRD, STI finished the experimental study on the preliminary evaluation of the first rocket-deployed drop-sonde observation in STY Mujigae

(2015), the article would be submitted soon.

- The demonstration research on the target typhoon (Mujigae) intensity change analysis using the cooperative experimental observation data by STI in collaboration with HKO and WMO TLFDP was in progress.

In addition, according to the 48th Session, the Terms and Conditions (T&C) of EXOTICCA for participating members was revised and discussed during the 11th IWS of TC. The revised document (Appendix I) of the T&C was distributed to Members for views and suggestions after 11th IWS. Comments on the T&C were received from Members and future plans for the project include:

- Endorse the revised T&C in the 49th Session (see Appendix I);
- Send an invitation to each Member and require for a response (join/not join);
- Depending on the response, we can consider whether an OC meeting is required, or merge with WMO-TLFDP as in last year.

3. Future planning and implementation schedule

The project is scheduled to be implemented from 2014 to 2018. The detailed plan in 2017 and beyond is as follows:

(1) 2017:

- To hold the OC and/or SSC meeting in 2017 for preparing the implementation of the experiment and confirm the tasks of participating TC Members in May, 2017, or to hold a joint workshop/progress meeting with WMO-TLFDP in October, 2017 (conjunction with WGM meeting if necessary).
- Both CMA and HKO will continued the field campaigns for 1-2 target typhoons from June to October by using multi-instrument including aircraft drop-sondes, mobile GPS radio-sondes, UAV and rocket drop-sondes.
- Collaboration among participating Members will be carried out in 2017, and a demonstration research will be planned (to be included in the TC Fellowship Scheme) which includes structure analysis, modelling and mechanism of target typhoon intensity change.

- To encourage TC WGs to establish their AOPs on target landfall typhoon flood forecasting and its related disasters risk.

(2) 2018:

- Joint scientific demonstration research on the effect of structure analysis, intensity changes and flood forecasting of landfall typhoon and its related disasters risk.
- Consolidating the outcomes and its demonstration applications plan of the project and submitting the project summary report to the Typhoon Committee Session in 2019.

Appendix I

The Terms and Conditions of EXOTICCA for Participating TC Members

1. Background

The Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA) was proposed by the China Meteorological Administration (CMA) and Hong Kong Observatory (HKO) during the 45th Session of the ESCAP/WMO Typhoon Committee (TC), held in Hong Kong of China from 29 January to 1 February 2013, and endorsed by 46th TC Session held in Bangkok, Thailand in 10-13 February 2014. The major goals and objectives of the EXOTICCA are: 1) to conduct the field campaigns on the intensity and structural characteristics of the target offshore and landfalling tropical cyclones by employing integrated and novel observation techniques, and 2) to conduct demonstration research on the utilization of the synergized field observation data with the aim of deepening the understanding of the mechanism of structure and intensity changes, improving the relevant capability of operational analysis, NWP models forecast, developing more reliable storm surge and flooding and associated risk assessment.

According to the request of the 46th and 47th Sessions, the Organization Committee (OC) of EXOTICCA was established. The first OC and kickoff meetings were held in Shanghai on 9 October 2015. The Terms of Reference of OC, the Scientific Steering Committee (SSC) Start-Up Scheme and Research Groups (RGs) were established. More information can be accessible from the Typhoon Committee website (<http://www.typhooncommittee.org/exoticca>)

To encourage participation of the Members and watch for opportunities to collaborate with other field experiments in the area, the 48th TC Session requested OC to further

develop the Terms and Conditions for Participating Members and report back to the 49th TC Session.

2. Term and conditions

Member Country of TC undertakes the responsibilities to take part in the EXOTICCA project (hereafter “the Project”) by:

- submitting a formal application to OC with the Term and Conditions signed by PR;
- providing a written notice to OC to express interests on field campaign and/or research activities of RGs, and nominating the expert(s) as a member of OC and/or RGs;
- participating in activities and meetings of the Project, including OC meeting to review and update the project implementation plan and annual action plan;
- sharing data, observations and other information relevant to the Project under the Member’s own data policy with other participating TC members if no objection from the participate TC Member; and
- providing one month’s written notice to OC should withdrawal from the Project become necessary

(signed by PR)
(date)