



World Meteorological Organization
RA IV HURRICANE COMMITTEE
FORTY-FIRST SESSION

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WMO secretariat
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AGENDA ITEM NO.4:

**COORDINATION WITHIN THE WMO TROPICAL
CYCLONE PROGRAMME**

ACTION REQUIRED:

The Committee is invited:

- a) Review the activities carried out under the TCP since its fortieth session (Fort de France, Martinique, France, 9 – 13 April 2018) and the proposals for the future, which are indicated in Appendix to this document or otherwise reported to the session; and,
- b) Consider what further measures, if any, may be taken to strengthen coordination between its own activities and those conducted under other parts of the TCP.

APPENDICES:

Appendix A – Draft Text for Inclusion in the Session Report
Appendix B – Coordination under WMO TCP

Appendix A – Draft Text for Inclusion in the Session Report

1. The Committee was presented about activities under, and those requiring coordination through, TCP. It appreciated the comprehensive presentation, and thanked WMO support to the Committee.

2. The Committee was informed by the WMO Secretariat that the 70th session of the WMO Executive Council (EC-70) made further decisions in relevance to the work of TCP. e.g. WMO DRR Roadmap, development of WMO Global Multi-Hazard Alert System (GMAS), Seamless GDPFS, Impact Based Forecasting (IBF), and constituent bodies reform, etc.

3. The Committee was informed that the Global Guide to Tropical Cyclone Forecasting has been reformatted with more readable and easily printable format. It can be downloaded at <https://cyclone.wmo.int/>.

4. The Committee was presented by WMO Secretariat about Recommendations of the Ninth International Workshop on Tropical Cyclones (IWTC-9) which happened in Honolulu, Hawaii, USA, 3-7 December 2018, and the outcomes and recommendations from the Ninth Tropical Cyclone RSMCs/TCWCs Technical Coordinating Meeting (TCM-9) (Honolulu, Hawaii, USA, 9-12 December 2018).

5. 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
- Support to DRR endeavours associated with tropical cyclones

Appendix B: Coordination under WMO TCP

ACTIVITIES CARRIED OUT UNDER THE TROPICAL CYCLONE PROGRAM SINCE ITS FORTIETH SESSION

1. INTRODUCTION

1.1 The WMO Tropical Cyclone Programme carries out its activities in accordance with decisions/resolutions by Congress and Executive Council and Regional Associations. The resolutions and decisions at the last Seventeenth World Meteorological Congress (Cg-17, Geneva, 25 May–12 June 2015) with particular relevance to the Programme may be found in paragraphs from 3.1.63-3.1.99 of the Abridged final report with resolutions of the Cg-17: WMO-No.1157: Tropical Cyclone Coordination and Services, at https://library.wmo.int/index.php?lvl=notice_display&id=18648

1.2 The 70th session of the WMO Executive Council (EC-70) made further decisions in relevance to the work of TCP. e.g. WMO DRR Roadmap, GMAS, Seamless GDPFS, Impact Based Forecasting (IBF), and constituent bodies reform, etc. For details. please refer to the EC-70 Abridged Final Report: WMO - No.1218 at https://library.wmo.int/index.php?lvl=notice_display&id=20626

2. PROGRAMME IMPLEMENTATION

2.1 The TCP was implemented in two components: a general component concerned with collective issues such as methodology and transfer of technology, and a regional component devoted to the activities of the five regional tropical cyclone bodies.

2.2 A list of the events organized or co-sponsored under the Programme during the period from April 2018 is given in <https://www.wmo.int/pages/prog/www/tcp/Activities.html>

2.3 During the 45th session of the WMO/ESCAP Panel on Tropical Cyclones in Muscat, Oman, 23 – 27 September 2018, the Islamic Republic of Iran, Qatar, Saudi Arabia, and United Arab Emirates joined as full Members of the Panel on Tropical Cyclones which now consists 13 Members.

2.4 The web version of the Global Guide to Tropical Cyclone Forecasting has been reformatted and printable version (in PDF format) has been available for download (<https://cyclone.wmo.int/>) since May 2017. It has been migrated to Hong Kong Observatory for long term availability.

3. COOPERATION WITH OTHER ORGANIZATIONS

3.1 There has been close cooperation and collaboration with the Economic and Social Commission for Asia and the Pacific (ESCAP), the United Nations International Strategy for Disaster Reduction (UNISDR) Secretariat, International Civil Aviation Organization (ICAO), World Bank, International Federation of Red Cross and Red Crescent (IFRC) and Secretariat of the Pacific Regional Environment Programme (SPREP) on a variety of matters of common concern. The main items include ESCAP's co-sponsorship of the Typhoon Committee and of the Panel on Tropical Cyclones, CREWS projects in Caribbean and South Pacific, as well as the UNISDR Secretariat in the context of the DRR of TCP.

3.2 As part of the cooperation between WMO and the International Civil Aviation Organization (ICAO), Tropical Cyclones Regional Specialized Meteorological Centres (TC RSMCs) and one Tropical Cyclone Warning Centre (TCWC) are designated as ICAO Tropical Cyclone Advisory Centres (TCAC) by ICAO Regional Air Navigation Agreements. Those TCACs listed below provide specialized tropical cyclone warning services for the aviation community:

RSMC/TCWC

Darwin (Australia)
 Honolulu (USA)
 La Réunion (France)
 Miami (USA)
 Nadi (Fiji)
 New Delhi (India)
 Tokyo (Japan)

Area(s) of responsibility

South-eastern Indian Ocean, South-western Pacific Ocean
 Central North Pacific
 South-western Indian Ocean
 North Atlantic, Caribbean, Eastern North Pacific
 Southern Pacific
 Bay of Bengal and the Arabian Sea
 Western North Pacific, including the South China Sea

4. Recommendations from the Ninth International Workshop on Tropical Cyclones (IWTC-9)

4.1 The Ninth International Workshop on Tropical Cyclones (IWTC-9) was held in Honolulu, Hawaii, USA, 3-7 December 2018. It discussed some essential topics in better understanding and forecasting of tropical cyclones. It made a list of recommendations to research community, operational community and WMO. The details of the recommendations may be seen in Annex I.

5. The Ninth Technical Coordinating Meeting (TCM-9)

5.1 The Ninth Tropical Cyclone RSMCs/TCWCs Technical Coordinating Meeting (TCM-9) was held in Honolulu, Hawaii, USA, 9-12 December 2018. The meeting reviewed actions taken since the previous meeting. It discussed and commented the recommendations of the IWTC-9 and of the 4th International Workshop on Tropical Cyclone Landfall Processes (IWTCLP-4, Macao, China, 5-7 December 2017). The meeting mainly focused on the following issues that require global coordination:

- TCP coordinated contribution to WMO Global Multi-Hazard Alert System
- Development of global tropical cyclone forecasting competencies
- Development of impact-based tropical cyclone forecasting products
- ICAO-related matters
- Rapid-scan observation coordination for tropical cyclones
- Overlapping of tropical cyclone names among different regions
- Tropical cyclone advisories with some texts on potential impacts
- TCP contribution to the IMO/WMO Worldwide Met-Ocean Information and Warning Service (WWMIWS)

6. ACTIONS FOR 2019 AND BEYOND

6.1 Major activities of TCP planned for 2019 in the global and regional components are set out below in summary form:

General component:

- a) Training and Capacity Development
 - Enhancement of the collaboration with other WMO Programmes in implementing TC training courses and workshops.
- b) Support to Operational Forecasting
 - Maintaining the Tropical Cyclone Forecaster Web Site with the support of Hong Kong, China.
 - Maintaining the reformatted Global Guide to Tropical Cyclone Forecasting
 - These two websites are popular in terms of access rate by public.
- c) Application of Research and Development (R&D)
 - Implementation of the TCP/WWRP joint projects;
 - TLFDP in Typhoon Committee region, including EXOTICCA.

- Research and Development Project on the Understanding and Prediction of Rainfall Associated with landFalling Tropical cyclones (UPDRAFT).
- Organizing the 3rd International Conference on Impacts of Climate Changes on Tropical Cyclones over Indian Ocean (Jointly with WWRP, Muscat, Oman, February 2020).

d) Global Coordination

- Development of the Tropical Cyclone Forecaster competency.
- Development of impact-based tropical cyclone forecasting and warning products.
- Coordinate to contribute to development of WMO GMAS.

Regional component:

- a) 51st session of the ESCAP/WMO Typhoon Committee (Guangzhou, China, 26 February – 1 March 2019)
- b) 41st session of RA IV Hurricane Committee (Curacao, Dutch Caribbean, 18 – 22 March 2019)
- c) 46th session of the WMO/ESCAP Panel on Tropical Cyclones (tentatively Myanmar, early September 2019, subject to confirmation)
- d) 23rd session of the RA I Tropical Cyclone Committee for the Southwest Indian Ocean (venue and dates to be determined)
- e) RA IV Workshop on Hurricane Forecasting and Warnings and Public Outreach (Miami, Florida, USA, 29 April – 10 May 2019)
- f) RA I Training Course on Tropical Cyclone Forecasting and Warnings and IBFs (La Reunion, France, September 2019)
- g) RA V Training Course on Tropical Cyclone Forecasting and Warnings and IBFs (Nadi, Fiji, September 2019, subject to confirmation)
- h) Forecaster Attachment Trainings in RSMC New Delhi, RSMC Tokyo, RSMC Miami, and RSMC La Reunion (dates to be determined).

6.2 In more general terms:

- Activities for the implementation of the Tropical Cyclone Programme section of the WMO Strategic Plan;
- Continued activities for the implementation of the Regional Cooperation Programmes, Technical Plans and other work programmes of the regional tropical cyclone bodies;
- Actions following decisions made by the Seventeenth WMO Congress (Cg-17), the Executive Council, the Regional Associations concerned and the regional tropical cyclone bodies.

Annex I: IWTC-9 Recommendations

1. Study how nonlinear interactions of environmental factors, and their multiscale nature, affect genesis, including multiple genesis events and baroclinically-influenced genesis. [RESEARCH]
2. Continue research studies to improve the understanding of the conditions, precursors, and processes leading to TC intensity change, taking into account its multiscale nature. Special focus should be given to rapid intensification, including onset, duration, and potential intensification rate. [RESEARCH]
3. Continue research on the interactions and processes that impact TC track, including structural changes [RESEARCH]
4. Continue research on SEF/ERC and associated structure and intensity changes, to guide operational forecasters on the likelihood of SEF/ERC, what wind field changes may occur, and whether the ERC will complete. [RESEARCH]
5. Develop a definition of extratropical transition (ET) that builds on cyclone phase space, but that takes into account different pathways to ET [RESEARCH]
6. Continue efforts to develop, improve, document, and maintain climate-quality datasets including periodic reanalysis of tropical cyclones and impact-relevant TC metrics across all ocean basins, reanalysis of large-scale atmosphere/ocean fields (e.g., ERA-5, JRA-55, etc), and error characteristics. Consider dynamically-consistent reanalysis using high resolution models and improve tropical cyclone representation in reanalysis and global climate models. [RESEARCH]
7. Encourage peer-reviewed attribution studies (or at least real-time attribution studies based on established peer-reviewed methods), as opposed to "real-time" attribution studies using un-reviewed methods. Trend attribution studies should include an expression of uncertainties and provide open access to data used. [RESEARCH]
8. Improve our understanding of the relationship between climate and TCs based on observations, theories, and climate models and including ocean coupling as a TC-relevant environmental condition. [RESEARCH]
9. More research on variabilities of various timescales that are important for subseasonal TC activity and forecasting is recommended. [RESEARCH] Additional efforts should be spent to improve region-specific forecasts and actionable information on tropical cyclones and associated landfall and user-relevant parameters on all time scales. [RESEARCH]
10. Expand the evaluation of the skill of climate models in representing TC activity from monthly to climate change timescales, using standardized verification techniques to allow comparison of different methodologies. Involve WMO verification groups in TC sub-seasonal verification and encourage the sharing of verification codes through public repositories. [RESEARCH]
11. Develop new aircraft, unmanned, tethered and ground-based observations of ocean and atmospheric fields and, when possible, provide real-time or near real-time, high quality, high-resolution observations in both space and time. [RESEARCH]
12. Improve targeted observations including airborne and space-borne measurements, such as those from new high-resolution satellite AMVs. Emphasis should be placed on weak systems, regions commonly with large forecast errors, and regions typically without airborne measurements [RESEARCH]
13. Develop an international community-based platform to support expanded research and development efforts on new intensity prediction methods to facilitate the real-time exchange of forecast model data, observational data, and the data inputs that are needed to drive intensity prediction techniques, and to facilitate consistent verification according to identified community standards [INTEGRATED RESEARCH AND OPERATIONS]

14. Implement new strategies to observe the TC inner-core and environment with high spatial and temporal resolution from the upper ocean (including pre-and post-storm) to the lower stratosphere. In particular, WMO requests the European Union's Earth Observation Programme (the space component of Copernicus) to prioritize access to C-Band SAR data collection from Sentinel -1A and 1B satellites in Wide swath mode over global tropical cyclones for the purpose of wind speed estimates (including RMW) for operational (and other) uses, provided that there is no additional cost. This would include the set up of an internationally coordinated framework for targeting SAR acquisitions on TCs. [RESEARCH, WMO]
15. Routinely analyze radii of maximum winds (RMW) and 34-kt winds (R34) and include these as best-tracked parameters in post-season best track databases for all basins. Standardized methods should be developed to guide the evaluation of these parameters and their error estimation. [INTEGRATED RESEARCH AND OPERATIONS]
16. Expand verification beyond current WMO guidelines to identify difficult cases of TC genesis, track, intensity, structure, and impacts. Such cases, as well as the metadata explaining why they were difficult cases, should be collated and stored on a community-based database for subsequent research by, e.g., involving the research group on forecast verification. [INTEGRATED RESEARCH AND OPERATIONS]
17. Explore the capability of issuing pre-genesis track, intensity, and size forecasts with watches and warnings as required for disturbances with a high probability of genesis, in particular near land. [OPERATIONS]
18. Consider working toward replacing static cones of uncertainty with dynamic types, which can be ensemble-based or hybrid statistical and dynamical techniques. [OPERATIONS]
19. Include social science aspects and knowledge of ensemble and uncertainty as (mandatory/desirable) components of basic meteorological training under WMO, e.g., Basic Instruction Package for Meteorologists (BIP-M), taking into account latest scientific advances and the forecasters' continually evolving role. [OPERATIONS]
20. Encourage access to forecast data (deterministic and ensemble; global/regional) and international data sets, particularly TIGGE, to facilitate research and operational use of ensemble forecasts. WMO should promote such sharing of data and code more widely across all topics covered in IWTC-9, e.g., by providing links to data sets from different sources. [INTEGRATED RESEARCH AND OPERATIONS , WMO]
21. Explore the possibility of standardizing the definition of TC genesis and how genesis is tracked, independent of basin and model configuration, to be used for forecast and verification purposes. [INTEGRATED RESEARCH AND OPERATIONS]
22. Explore the possibility of a consistent definition of SEF/ERC onset, including confidence levels, that is useful for both the research and operational community, and use it to develop a database for use by the research community [INTEGRATED RESEARCH AND OPERATIONS]
23. Advance intensity forecast guidance, visualization and integration into operational centers, including diagnostics (especially vertical wind shear), dynamic models, statistical-dynamical techniques, machine learning approaches, and ensembles to promote probabilistic intensity output. [INTEGRATED RESEARCH AND OPERATIONS]
24. Establish an objective database of developing and non-developing disturbances. Include storm characteristics such as center location, Dvorak CI number, and Invest designation, when applicable. [INTEGRATED RESEARCH AND OPERATIONS]
25. Support efforts to make current and future research and developmental satellite data and products available in real-time or near real-time and aggregate the products on a web site. Upon successful demonstration of capability from research missions, efforts should be made to transition these capabilities to operations by operational entities and provide appropriate training. [INTEGRATED RESEARCH AND OPERATIONS]

26. Coordinate researchers, operational forecasters and social scientists to jointly work together to design early warning systems using impact-based parameters with users in mind taking into consideration the decision-making processes, cascading TC impacts, forecast uncertainties, and varying capacity to respond. Special emphasis should be placed on maximizing the use of social media in a responsible manner, as a platform to engage communities. [INTEGRATED RESEARCH AND OPERATIONS, WMO]
27. Coordinate the transfer of all forecast (including probabilistic) tools and guidance to all TC forecast agencies. [WMO]
28. Coordinate an intercomparison project on different diagnostic techniques, such as ensemble sensitivities, to better understand large errors associated with forecast busts from existing databases such as the TIGGE and WGNE collection of model forecasts on ensemble sensitivity experiments. [WMO]
29. Assist with multi-region and multi-center coordination of TC reconnaissance efforts and promote the real-time sharing and exchange of aircraft/UAV –based observational data in a standardized format to encourage easy use for modeling centers and forecasters. (WMO)
30. Promote the real-time sharing of airborne and land-based observations (WMO).
31. Encourage the growing number of research and operational programs that are providing validation data for radar-derived, aircraft-derived and satellite-derived surface wind speeds/vectors outside the Atlantic basin. These efforts would include support for validation and development needed for assimilation into NWP. (WMO)
32. Encourage and support another International Workshop on Satellite Analysis of Tropical Cyclones (IWSATC) in the near future, expanding the role to better reach underdeveloped TC-prone countries to provide information on the satellite sensors, data availability, data accessibility, and platforms and to develop training for how to use the products/applications. (WMO)
33. Encourage sharing of and facilitate the training of advances in observing and modelling subseasonal TC basin-wide activity. (WMO)
34. Encourage the opportunity for major interdisciplinary research activity in the Asian Region aimed at improving the information available to typhoon forecasters and providing the research needed to enhance the communication and utility of typhoon warnings. This should be a pilot project for the seamless Global Data Processing and Forecasting System co-designed between WWRP and any interested regional body/ies in the Asian region to ensure a strong linkage between research and operational forecasting. The WWRP focal point of the activity would be its HIWeather project with significant contributions from all WWRP Working Groups and from WGNE. IWTC-9 recommends that interested parties meet early 2019 to discuss the development of such an activity. [INTEGRATED RESEARCH AND OPERATIONS, WMO]