

Report of the 50th Session of

World Meteorological Organization/Economic and Social Commission for Asia and the Pacific

WMO/ESCAP PANEL ON TROPICAL CYCLONES

FIFTIETH SESSION

Manama, Kingdom of Bahrain 19—23 December 2023

Item Number 1 (1.1 to 1.4)

1.1 Inauguration of the session

The PTC-50 Session was inaugurated on 19th December by His Excellency, **Mr. Mohammed Bin Thamer Al Kaabai**, the Hon'ble Minister of Transport and Telecommunications, Kingdom of Bahrain. In his inaugural address the Hon'ble Minister appreciated the cyclone warning services in the region. He also urged all in the region to work together for better future.

His Excellency, Dr. Abdulla Ahmed Al Mandous, WMO President, Director General, National Centre of Meteorology, United Arab Emirates and PR of UAE to WMO, in his Welcome Address thanked Kingdom of Bahrain for hosting the Session. He welcomed all the member countries and appreciated RSMC New Delhi, India Meteorological Department for providing successfully Tropical Cyclone forecast and Advisories over the NIO region including the Bay of Bengal & the Arabian Sea and helping in capacity building of the tropical cyclone forecasters of the National Meteorological and Hydrological Services in the region. He also highlighted the requirements of an effective Early Warning System in view of rising trends in frequency and intensity of tropical cyclones particularly over Arabian Sea. He urged the meteorological community to build a future that is not afraid of disaster, but will be resilient to disaster through collective efforts.

Dr. Wenjian Zhang, Assistant Secretary General, WMO welcomed all the participants. He highlighted that tropical cyclone is one of the biggest meteorological hazard that causes economic losses. Promoting UN's Early Warning for All initiatives, he urged all UN partners to join Panel activities for a better future. He highlighted the role of effective communication and development of disaster resilient infrastructure in the value chain.

Dr. Mrutyunjay Mohapatra, DGM IMD, PR of India to WMO and 3rd Vice President of WMO participated as Guest of Honour during the programme. In his speech, Dr. Mohapatra highlighted the role of India in building the Tropical Cyclone Forecasting System over the region. He stressed upon implementing "Early Warning for All" in this socio-economically diverse region. The impact-based forecast along with augmentation of observational network and implementation of Common Alert Protocol in all the countries are the needs of the hour. Mr. Ayman Salem Ghulam, Chief Executive, National Centre of Meteorology-Saudi Arabia and the Chairman, WMOESCAP PTC also spoke on the occasion.



Fig.1: Delegates from WMO/ESCAP PTC Member Countries, WMO and UN participating in the Inaugural Session on 19th December 2023

1.2 Election of the Chairperson and Vice-chairperson

The Panel elected chairperson and vice-chairperson to serve during the session and for the period until the fifty-first session. The Current Chair **Dr. Ayman Salem Ghulam**, Chairperson of WMO/ESCAP Panel on Tropical Cyclones, Chief Executive, National Center of Meteorology- Saudi Arabia retained in the positions until PTC-51). Dr. Abdulla Almannai from Qatar will be the vice chair during this period.

1.3 Adoption of the Agenda

The provisional annotated agenda was approved in the session. The order of the agenda was modified during the session and additional items were introduced.

1.4 Working arrangements

The panel agreed to appoint **Dr. D. R. Pattanaik**, Head RSMC, IMD as the rapporteur and **Dr. Kalam Mallik** of BMD as co-rapporteur for this session.

1.5 One-day technical conference coordinated by RSMC, New Delhi

After the inaugural session of PTC-50 on 19th December 2023 in Bahrain, the celebration was marked with **one-day Technical Workshop organised by WMO/ESCAP PTC and coordinated by Regional Specialised Meteorological Centre (RSMC) New Delhi**. The programme for the technical session is given below.



Technical Conference on Advancements of Cyclone Warning Services
through

WMO/ESCAP Panel on Tropical Cyclones

Venue: Kingdom of Bahrain

Date: 19th December, 2023



Time	Program Details
	Technical Session I (90 minutes)
1110-1240	<p>Session 1: Achievements and current status of WMO/ ESCAP PTC on Tropical Cyclones monitoring and forecasting</p> <p>Chair: Dr Abdulla Ahmed AL MANDOUS, President of WMO Co-Chair: Dr Ayman Salem Ghulam, Chairperson of WMO/ESCAP PTC Presentation by Dr. D. R. Pattanaik, Head RSMC on</p> <ul style="list-style-type: none"> • “Evolution of Institutional Mechanism” leading to the development of PTC and its journey in last 50 years” <p>Presentation by member countries (8-10 minutes each) with respect to current status</p> <ul style="list-style-type: none"> • TC monitoring and forecasting • Severe weather monitoring and forecasting • Warning communication and co-ordination
1240-1320	<p>Panel discussion on Status and Gap (30 minutes)</p> <p>Chair: Dr Abdulla Ahmed AL MANDOUS, President of WMO Co-Chair: Dr. Ayman Salem Ghulam, Chairperson of WMO/ESCAP PTC Panelist: One representative of each country Moderator: Dr. Sanjay Kumar Srivastava, Chief DRR, IDD, UNESCAP</p>
1320-1420	Lunch Break
	Technical Session II (120 minutes)
1420-1620	<p>Session 2: Future Prospects of TC Monitoring, Forecasting & Warning Services</p> <p>Chair: Dr Taoyong Peng, Head, DRR Technical Development Division, WMO Co-Chair: Dr. Sanjay Srivastava, Chief DRR, IDD, UNESCAP Rapporteur : Mrs. Monica Sharma, IMD</p> <p>Presentation by member countries (25 minutes each) on</p> <ul style="list-style-type: none"> • Impact-Based Forecasting: Dr. Sanjay Kumar Srivastava, Chief DRR, IDD, UNESCAP • Web DCRA & Decision Support System: Dr. D R Pattanaik, RSMC New Delhi • Common Alerting Protocol: Adanna Robertson-Quimby, WMO • Early Warning for All: Dr. Taoyong Peng, WMO • AI/ML Techniques for cyclone monitoring & forecasting: Dr Kuanghui Zhou, WMO
1620-1630	Tea Break
1630-1715	<p>Panel discussion on Future Strategy (45 minutes)</p> <p>Moderator: Dr. M. Mohapatra, PR of India & 3rd Vice President of WMO</p>
1715-1730	Concluding Session (15 minutes)

1.5.1 :In the workshop, Dr. D R Pattanaik, Head RSMC New Delhi presented about the “**Evolution of Institutional Mechanism**” leading to the development of PTC and its journey in last 50 years. He also presented the activities carried out by RSMC, New Delhi to celebrate 50 years of RSMC New Delhi and WMO/ESCAP PTC. It included the following:

- a. Lecture Series by eminent personalities from different member countries of PTC: The lectures series was commenced in August with the talk by Dr. M. Mohapatra and subsequently continued till November 2023 with a total of 11 lectures by experts from the region. All these lectures are available in YouTube links. Dr. Pattanaik thanked Mrs. Monica Sharma, RSMC New Delhi to organise the same and the support provided by UN ESCAP and all resource persons from the panel countries.
- b. Special issue in a reviewed journal on Cyclone forecasting over North Indian Ocean : Dr. Pattanaik also talked about bringing out a special edition of a Journal (**Tropical Cyclone Research and Review**) with articles from all expert speakers who presented the special lectures in the 3 months long lecture series organised by RSMC along with a few more invited articles from the experts.
- c. International Quiz Competition to popularise cyclone warnings in the region : He talked about the International online Quiz Competition organised by RSMC New Delhi during September to 21st November, 2023 with participation of more than 5000 people. It was a success story and certificates were given to all the participants.
- d. National and International Conference : Dr Pattanaik presented about the event conducted by member countries. Iran conducted one day International Workshop and Pakistan conducted one day National Workshop.

RSMC also arranged one-day Technical Workshop on 19th December to commemorate 50 years of PTC in Bahrain with the theme “**WMO/ESCAP PTC @ 50: Past, Present & Future**”. This technical session aimed to discuss (i) Current Status, Achievements and Challenges in TC Forecasting and (ii) Future Strategy for TC forecasting in PTC region.

Dr. Pattanaik also mentioned about the 150th years of celebration of IMD from 15 Jan 2024 to 15th January 2025. It is proposed to organise an International Workshop in 2024 with participation from various countries as well as PTC Member countries.

- e. Development of PTC logo representing completion of 50 years: In this regard, the proposed Logo suggested by member countries were presented and one logo was suggested for acceptance by the members.
- f. Development of documentaries on cyclones to increase awareness: IMD has developed a documentary film on “**Early Warning and Early Action: A Success Story**”. The film is available on RSMC website at link: <https://www.youtube.com/watch?v=ET68Nozu2fo>

Finally, Dr Pattanaik appreciated the work done by colleagues from RSMC, New Delhi (Mrs. Monica Sharma) under the leadership of Dr. M. Mohapatra, DG IMD, Dr. Srivastava from the UNESCAP, Dr.T. C. Peng from WMO and the experts from PTC Panel countries for providing all supports in carrying out these activities by RSMC, New Delhi.

Representatives of the Member Countries of PTC and experts from WMO and UN-ESCAP also made presentations on various aspects of current status, achievements, gap areas and the future strategies.

1.5.2 : Mrs. Monica Sharma, Scientist D, RSMC New Delhi presented the Current Status, Challenges and Future Plans in Monitoring and Forecasting of Tropical Cyclones over North Indian Ocean region during the Technical Session. She discussed about the vulnerabilities due to Tropical Cyclones (TCs) over the North Indian Ocean (NIO) and current status in terms of observations, modeling, warning products generation & dissemination, gap areas and plans for future. She also discussed major decisions that brought paradigm shift in cyclone warning services over the region. She also discussed the difficult and challenging TCs during last 5 years (2019-23). During the presentation various issues wrt gaps in science, observational systems, modeling systems and warning dissemination system were highlighted. Following new initiatives in 2023 were discussed by RSMC New Delhi:

- risk based warnings based on threshold method in tabular and graphical format for next 5 days
- introduction of hazard forecast for wind, rainfall and inundation upto village level through Web-based Dynamic Composite Risk Atlas alongwith forecast of economic losses to various exposure elements. This helps the government to release pre-disaster relief funds.
- Common alert protocol for warning dissemination

Recommendations: PTC took note of the development and recommended that Member countries may take advantage of the tools and products developed by IMD for their use in formulating various forecast and warning

The identified gap areas in science and challenges may be shared to all countries including all difficult cases of cyclones for necessary action by NMHSs.

The one-day technical session also included the following talks by the experts: -

- Impact-Based Forecasting: Dr. Sanjay Kumar Srivastava, Chief DRR, IDD, UNESCAP
- Web DCRA and: Decision Support System: Dr. D R Pattanaik, RSMC New Delhi
- Common Alerting Protocol: Adanna Robertson-Quimby, WMO
- Early Warning for All: Dr. TaoyongPeng, WMO
- AI/ML Techniques for cyclone monitoring and forecasting: DrKuanghui Zhou, WMO

1.5.3: Web- DCRA (Dynamic composite Risk Atlas): By Dr. D. R. Pattanaik, Head RSMC, IMD New Delhi delivered a talk on “WEB-DCRA”.

This is a Web-based decision support system called Web – DCRA (Dynamic composite Risk Atlas). This has been developed under the joint efforts with the India Meteorological Department / MoES & the National Cyclone Risk Mitigation Project (NCRMP) of National Disaster Management Authority (NDMA), Government of India for utilization in the Cyclone-prone coastal states. The purpose of this tool is mainly for static pre-event planning and dynamic response (responding to a real-time cyclone) for 13 cyclone-prone States and Union Territories of India. This system includes ‘Development of Probabilistic Risk Assessment Maps / Products (stochastic scenario-based approach to Probabilistic Risk

Modeling) for depiction of cyclone risk and storm surge flooding / coastal flooding vulnerability maps for the coastline of India' and the products are visualized through an interactive map viewer.

Thus, the brief objectives of Web-DCRA cover:

- ❖ Hazard, vulnerability and Risk assessment at village level
- ❖ Developing probabilistic products for the hazard forecast
- ❖ It is a dynamic risk assessment tool
- ❖ Exposure conditions are updated twice a year
- ❖ Supports decision-making at the State/District and local levels,

The system was fully operationalised during the Biparjoy cyclone (2023) and the information concerning wind, flood, and coastal inundation hazard was shared in real-time along with the economic losses to various exposure elements. It enabled the disaster managers to not only achieve zero death target but also helped minimize the economic losses by judicious planning & preparedness. Dr. Pattanaik also presented how the Web-DCRA portal was used in the case of the recent cyclone “**Michaung**”.

As a part of this project, it is also envisaged to develop an App (the web-DCRA App) specifically meant for communicating with the users (Disaster managers and all other Stake holders including the General public) to access the Cyclone warning related updates during the event while on move as well as to provide pertinent information related to mitigation activities.

1.5.4 : Impact-Based Forecasting for Early and Anticipatory Actions: By Dr. Sanjay Srivastava, UNESCAP

It was recommended scaling up IBF to support early actions through PTC Attachment training and WMO/ESCAP dedicated IBF training. Furthermore, IBF should be scaled up through the UN Early Warnings for All initiative– Pillar 2 – Impact based Forecasting.

It was also suggested that IBF should be included in Synergized Standard Operating Procedure for Coastal Multi-hazard Early Warning System (SSOP III) in PTC member Countries. PTC should undertake resource mobilization for IBF through Green Climate Fund, CREW, ESCAP Trust Fund and dedicated support from PTC members.

1.5.5 : A presentation was made by Ahmed Ghawas, OMAN

A presentation was made on “Meteorological Events” that occurred in 2023. During the 2023 tropical cyclone seasons, Oman was impacted by tropical cyclone TEJ, which was the second tropical cyclone developed over the Arabian Sea, following Biparjoy tropical cyclone that impacted India and Pakistan. Both cyclones intensified significantly, with Biparjoy reaching Category-3 and TeJ to a Category-3 tropical cyclone, as classified by the Oman Directorate General of Meteorology (DGMET). The impact of TeJ tropical cyclone was on Socatral Island and parts of South Oman and Yemen. It landed on October 23, 2023 a tropical storm in the Al Mahra Governorate near the Oman border, with maximum sustained winds of 55-63 kt (102-117 km/h). It brought more than 200 mm of rainfall over Dhalkut in three days. The successful mitigation of damage and casualties is credited to the timely

warnings issued by DGMET and the continuous dissemination of accurate guidance to decision-makers and civil defence, where the port was temporarily shut down and a hospital evacuated because of the storm.

The system formed over the southeast of the Arabian Sea originated as a low-pressure area on October 18, 2023. TEJ overall movement was west to northwest towards Arabian Peninsula Coast. Strengthen rapidly on 22 October, from Category 1 to Category 3 within 8 hours when it was located over the sea, north of Socatra Island. As it approached the Yemen Coast, it began to weaken gradually from October 23, 0400 UTC, TEJ maintained its weakened state, classified as a tropical storm by DGMET on October 23, 1800 UTC, during the landfall until its dissipation inland over Dhofar Governorate.

The presentation also mentioned about the Meteorological Facilities available in Oman including the (i) 2 Upper Air Observation at Muscat (41256) and Salalah (41316), (ii) Ship Weather Reports from Ships are received through GTS, (iii) Wave Measurements from twelve (12) wave radar measurement station were installed offshore of Oman Sea and Arabian Sea. These radars are collecting observations for almost six (6) locations. And a number of seven (7) tide gauges were installed disrupted offshore Oman Sea and Arabian Sea as part of Tsunami detection Network. These wave radars and Tide gauges are part of the early warning system operated by CAA Oman. There are also four (4) Marine Stations in different Locations along Oman coastal water, (iv) 75 meteorological stations out of which 23 are listed in the WMO's Regional Basic Synoptic Network (RBSN) (v) Five Dual Polarization S-Band Doppler Weather Radar have been commissioned and one more is expected to be commissioned soon, (vi) Satellite reception The Department continue operating a Satellite ground receiving station for intercepting High Resolution images from Polar Orbiting satellites operated by NOAA, EUMETSAT and China as well as from geostationary satellites operated by EUMETSAT. The facility available regarding the telecommunication, numerical modelling, early warning system implemented in 2014, visualization, Flash Flood Guidance (OMANFFG), storm surge, seasonal forecast, Aeronautical Services, training/research, quality management services etc were also presented.

Also a number of courses on satellite application field have been organized by the WMO Oman Center of Excellence COE in Muscat. During the period from 19th to 23rd of March the COE conducted the annual Eumetsat Satellite application course with a round 12 participants. The Center also organized a trainer training course in use of the third generation satellite products.

1.5.6 : A presentation was made by DrKanghui Zhou, WMO AI professional officer on "Application of data-driven AI weather forecast in TC forecasting and warning"

Dr.Zhou presented about Fast development of Data driven weather forecasting and he discussed about (i) NVIDIA-FourCastNet,(ii) NVIDIA-FourCastNet, (iii) Huawei -PanguWeather, (iv) Microsoft-ClimaX, (v) Alibaba-SwinRDM, (vi) ECMWF-AIFS

Dr. Zhou presented the results based on all the above mentioned AI tools. The results on the application of AI tool Pangu-Weather on Tropical cyclone prediction was discussed in detail with results indication:

- Betterperformance in TC position prediction
- TC intensity forecast need to be improved.

- Extreme value prediction is still a common challenge for all AI models.
- Post-processing method could be applied in the future.
- Dr. Zhou also presented about the new “Initiative for AI for TC forecast demonstration project (FDP)” with goals and expected outcome as given below.

Goals

- Investigate the impact of AI in TC forecasting workflow
- Improve the TC forecasting with AI to support the EW4ALL Initiative
- Comprehensively Evaluate AI’s potential for TC forecasting
- Provide operational AI-driven TC Forecasting Tools
- **Expected Outcomes**
 - AI-enhanced TC Prediction Tools and Products, including ensemble and deterministic TC forecast products
 - Comprehensive Report on AI for TC prediction, including impact on TC operational work-flow
 - AI for TC Prediction Guidelines for WMO Members

Finally, he emphasized the requirement of staff, funding, training, workshops, etc for carrying out this of Tropical Cyclone forecasting using AI tools.

Staff

Recommendation :PTC along with ESCAP can prepare a plan to take accelerate the work of tropical cyclone forecasting with AI tools for the improvement of track and intensity prediction.

2 FOLLOW-UP ACTIONS ON PTC-49

The Panel reviewed the recommendations of the forty-ninth session and the actions taken, if any.

- a) Organisation of lecture series with experts as PRs of member countries.
- b) Special issue in a reviewed journal on Cyclone forecasting over North Indian
- c) International Quiz Competition to popularise cyclone warnings in the region
- d) Organisation of National and International
- e) Development of PTC logo representing completion of 50 years
- f) Development of documentaries on cyclones to increase awareness
- g) Designing of PTC logo
- h) Organisation of technical conference prior to the next Panel session – PTC-50
- i) To improve outreach through interviews to press and electronic media.
- j) To develop vision or goal statement for next 10 years (Action: RSMC New Delhi and Member countries)
- k) Publish leaflets, brochures etc highlighting the achievements. (Action: RSMC New Delhi and all member countries)

3 REPORT OF THE CHAIRPERSON OF THE PANEL

The chairperson of the Panel will be invited to make a brief report at the session on the activities carried out since the forty-ninth session of the Panel in September 2022 and on other relevant matters. The report may also draw attention to developments of concern to the Panel and suggest particular activities to which special attention could be given in the future.

Reports of the Chairperson of the Panel was presented.

-- Key Activities and Main Events in the Region --

During the inter-sessional period from June 2022 to November 2023, the following major activities happened in the PTC region:

- The forty-ninth session of the Panel was held online and hosted by the Kingdom of Saudi Arabia, from 27 – 30 June 2022. The session was attended by 68 participants from the thirteen Members of the Panel, and representatives from ESCAP and WMO, and observer from GCC, APDIM and China. The Panel reviewed the 2021-2022 cyclone seasons, and discussed possible changes in the frequency and intensification of tropical cyclones. Follow-up actions were made by WMO and UNESCAP within the subject areas have been presented separately to the Panel.
- At the session, the Panel Members reviewed and updated the Tropical Cyclone Operational Plan; discussed internal matters of the PTC; discussed and planned to commemorate the 50 years of the PTC, etc.; requested a training activity for IBF workshop.
- The “RSMC New Delhi- Attachment Training on Operational Tropical Cyclone Forecasting” was conducted online from 3 to 13 April 2023. It was attended by 26 participants not including those from India.
- At the request of PTC at its 49th session, WMO PTC/ GCC Workshop on Impact-based Forecast and Warning Services was held in Muscat, Sultanate of Oman, 05-09 November 2023, with its purpose of building the capacity of the NMHSs in implementing IBFWS, making this implementation sustainable by integrating IBFWS into standard operating procedures (SOPs), and promoting its value for other relevant hazards, with disaster management authority (DMAs), public and private stakeholders.
- RSMC New Delhi provided tropical cyclone forecasting advisories in timely manners with required frequency and good accuracy for all tropical cyclones in the Bay of Bengal and the Arabia Sea. Of particular mentioning is that the RSMC New Delhi provided timely and accurate forecasting products to UN Humanitarian agencies like UNHCR and UNOCHA on tropical cyclone “Mocha” when it was approaching refugee camps. The UN agencies sent to WMO SG letters of appreciation for such excellent services.
- Under the leadership of RSMC New Delhi, a series of lectures were organized to commemorate the 50th anniversary of PTC. PTC Members and WMO and ESCAP were invited to present their achievements for the past 50 years in tropical cyclone monitoring, forecasting, warning and disaster mitigation, and national capacity development efforts.
- The Chair sent an invitation to PTC Members calling for voluntary contribution to hosting the PTC Secretariat. So far three replies have been received.

- The Chair sent an invitation to PTC Members to nominate their representatives to participate in the 50th session of the PTC. The PTC 50th session also devoted one day to a technical conference to overview advances and developments in sciences and technologies to support tropical cyclone monitoring and forecasting capabilities, in step with the application of new technologies.
- Under the initiative of the RSMC New Delhi to address PTC-49 call for establish a PTC Logo, progress is ongoing well in designing a PTC logo, and ready for discussion to identify the PTC logo.

4 REVIEW OF THE 2022 AND 2023 CYCLONE SEASONS

The Panel was concerned with seeking ways of improving tropical cyclone warning services for the benefit of the Members. A detailed review of the actual events of the past cyclone season was carried out as a prelude to discussing ways of improving the facilities available, the existing cooperative and coordinated arrangements, and the services provided.

4.2 Report of RSMC Tropical Cyclones New Delhi.

The Panel made an overall review of the 2022 and 2023 cyclone seasons based on the seasonal summary submitted by the RSMC-Tropical Cyclones New Delhi as a technical report. Behavior of individual cyclones and forecast performance of RSMC New Delhi will be presented in the report.

Mrs. Monica Sharma, Scientist, RSMC New Delhi presented a Review of the Cyclone Season 2022 and 2023

- During the year 2022, there were 15 cyclonic disturbances (CDs) (maximum sustained wind speed ≥ 17 knots) with formation of three cyclones Asani, Sitrang and Mandous. Annual activity was above normal with formation of 15 CDs against normal of 11.2 per year (1965-2021). Category-wise, overall more depressions (12 depressions against normal of 6.5 per year) and less cyclones (3 against normal of 4.7 per year) formed in 2022. Basin-wise activity was above normal over Bay of Bengal compared to Arabian Sea. Season-wise, there were 4 CDs during pre-monsoon season (Normal: 1.4 per year), 6 CDs during monsoon season (Normal: 4.9 per year), 5 during post-monsoon season (Normal: 4.8 per year). Overall activity was above normal during pre-monsoon. All the 3 cyclones had recurving tracks. Two (Sitrang and Mandous) crossed coast as cyclone and Asani crossed as a deep depression. The frequency of landfalling cyclones was below normal. The forecast performance during each cyclone was presented.
- During the year 2023, there were 9 CDs against normal of 11.2/year (1965-2021). The activity was below normal. Category-wise, there were 3 depressions/deep depression against normal of 6.5 per year. It was less than normal and 6 cyclones against normal of 4.7 per year. Overall, there were less depressions and more severe cyclones during 2023. Basin-wise, there were 3 CDs over Arabian Sea (Normal: 2.3 per year) (Above Normal), 6 over Bay of Bengal (Normal: 7.8 per year) (Below Normal). Activity was above normal over Arabian Sea and below normal over Bay of Bengal. All the 6 cyclones had recurving tracks. All crossed coast as a cyclone. The activity of landfalling cyclones was above normal.

- RSMC New Delhi maintained round the clock watch over the North Indian Ocean and monitored & predicted all the cyclonic disturbances with accuracy and with sufficient lead period. A seamless flow of advisories was maintained from extended range outlook to nowcast on the day of landfall.
- Comparative analysis of the operational forecast errors during 2014-18 vis-à-vis 2019-23 were presented.
- The operational track forecast errors were 72km(86km), 112km(132km), 156km(178km), 201km(243km) and 286km(285km) during 2019-23(2014-18) for 24, 48, 72, 96,120 hours lead period respectively.
- The operational landfall point forecast errors were 18km(47km), 42km(70km), 73km(104km) during 2019-23(2014-18) for 24, 48 and 72 hours lead period respectively.
- The operational intensity forecast errors were 7 knots(10 knots), 10 knots(14knots), 14knots(16 knots), 17 knots(17 knots) and 18 knots(11 knots) during 2019-23(2014-18) for 24, 48, 72, 96,120 hours lead period respectively.

For further improvements in forecast accuracy and services, following suggestions were proposed:

- Member countries were requested to share observational data through GTS.
- After each cyclone lessons learnt to be consolidated and shared with forecasters for further improvements
- RSMC shares the report with all members. Members may also share with us the feedback for further improvements.
- RSMC will share the difficult cases statistics with members for further research & development
- RSMC New Delhi is sharing cyclone data through APIs. The same can be shared with members as per request
- IMD conducts regular trainings on Satellite, Radar, NWP Models, Severe Weather Forecasting. Can be arranged for member countries as well as per request.

Recommendations: The PTC appreciated RSMC, New Delhi for providing real time tropical weather outlooks and tropical cyclone advisories during 2022 and 2023 to the member countries.

The PTC while noting the improvement suggestions urged upon NMHSs and RSMCs to enhance the real time and past data sharing, improve the R&D on tropical cyclone monitoring and forecasting.

4.3 ReportsofMembersontheimpactoftropicalcyclones

Members who have experienced the impact of tropical cyclones and/or other related severe weather events during late 2022 and 2023 will be invited to submit to the session concise reports on the functioning of the warning systems, lessons to be derivedfromtheseevents,measuresalreadytakenasaconsequenceand proposals, if any, as part of the country report. The Panel may wish to review these reportsanddiscussoperationalmattersandshortcomingstoimprovetropical cyclone warning services.

4.3.1. Bangladesh's Report : By Dr. Muhammad Abul Kalam Mallik

Four cyclonic storms in the year 2023 formed over the Bay of Bengal and three cyclones make landfall over Bangladesh and had major impacts which were reported. The forecast and warning services by the BMD were provided with adequate lead time to prepare and execute mitigation actions. The damages and loss to properties could not be avoided but minimized with proper preparedness by the disaster manager, relevant authorities and public following the warning guidelines. A brief of impact information for individual cyclones is discussed in the country presentation. In 2023 a deep depression also formed over the Bay of Bengal in August and Bangladesh experiences high amount of rainfall and has a great impact on agriculture. This year unusual heat wave swept over Bangladesh from April to September due to its different impacts occurred in Bangladesh specially in agriculture, transportation, power and health sectors.

There has been a further expansion in the monitoring network of observations (Doppler weather RADARs, upper Air, automatic weather stations and surface-based observations etc.). The more specifically lightning detectors along with Satellite Observational facilities (Himawari, Feng Yang, Meteosat and GK-2A receiving systems) data has been portrayed. The future enhancement in various observation networks have also been presented separately. Performance of operational NWP models were discussed with a focus on the rapid/slow intensity, track and landfall processes & time and location specific landfall forecasts. Bangladesh utilizes various NWP (WRF, NHM, ECMWF model visualized by Diana, MRI storm surge) models to attain at the final official forecasts for a specific cyclonic disturbance. The forecast products of the NWP modeling systems in other agencies such as RSMC, NCMRWF and IITM, Pune for different spatial and temporal scales were also followed in an integrated manner in delivering final forecasts. A systematic workshop with different stakeholders was arranged by Bangladesh Meteorological Department with the support of RIMES on Impact Based Forecasts (IBF) to move from hazard-based forecast to IBF but still some challenges on implementation of IBF in Bangladesh due to lack of sector-wise good data sets.

The Government of Bangladesh, that has sophisticated Disaster Management Systems in place, and together with the humanitarian community worked extensively on preparing for the worst-case scenario on a 'no regrets' basis. Years of planning and training paid off and all efforts were made to protect the most vulnerable communities. The Government and its partners in the United Nations (UN), Red Cross/Red Crescent family, and Non-Governmental Organizations (NGO) community have worked to reinforce preparedness activities such as early warning protocols, community outreach messages and signals, establishment of Disaster Management Committees, organized relocations, coordinated cash and food distribution and much more. In the aftermath of the Cyclone, the Government also led efforts to provide immediate assistance.

The improvements made in the Tele-communication system for data reception & dissemination was discussed with respect to various components. The progress is done in terms of warning product design and dissemination procedure with different communication media including SMS, Social Media platforms, mobile Apps, Fax, Website : www.bmd.gov.bd, Telephone, Bangladesh Betar and Television, E-mail, BMD Weather APP, IVR, direct call 1090, Facebook, Twitter, GOVT. Help Line 333, Electronic and Print

media etc., Bangladesh has a plan to start Common Alert Protocol (CAP) and crowd sourcing as early as possible for effectively utilized to reach out to the users.

Training activities are continued via offline as well as online (virtual) modes for national and regional forecasters and others employees by Meteorological Training Institute of BMD. Different regular long term training courses and many short-term refresher courses have been conducted by the training institute. Two training workshop on 'Impact based forecast' and 'Numerical Weather Prediction (NWP)' were conducted by storm warning center of BMD.

4.3.2 Country Report of Pakistan by Dr. Sarfaraz, Chief Meteorologist

The 2022 was an exceptionally abnormal year for Pakistan from hydromet hazards point of view. From a severe snowstorm in the month of January to a massive heatwave across large swaths of the country during March - June, followed by unprecedented torrential monsoon rains (Jul-Sep) and huge GLOF (Glacial Lake Outburst Flood) events the country had experienced. The snowstorm at a hilly station Murree caused about 30 human lives, though there was a weather alert issued by the PMD. There were six heatwaves (maximum temperatures been 5-12°C above average) which parched the country plains badly affecting the crops, livestock and human health and then the incessant monsoon rains in July (181% above normal) and August (243% above normal) triggered massive flooding that took over 1700 lives, affected 33 million people displacing 7.9 million and causing \$32m economic loss. The annual national mean temperature for 2022 was 0.84 °C above average, placing it as fifth-warmest year on record with March and April being the hottest ever months on record. Daily maximum temperatures set new records at several locations in the country. Contrary to 2022, the year 2023 remained relatively calm with Jan, Feb, Aug & Sep being rain- deficient months, while, March to July and Oct-Nov being largely surplus rain months. For temperature, Jan and Apr-July were cooler than average while Feb and Aug-Nov were warmer than average months.

Tropical Cyclones (TC) Monitoring

During this year, two TCs formed over the Arabian Sea *BIPARJOY* in June and *TEJ* in October. The Cyclonic Storm (CS) *BIPARJOY* formed on 7 June, intensified first into a Severe Cyclonic Storm (SCS) on 8 June then into a Very Severe Cyclonic Storm (VSCS) on 11 June and further into an Extremely Severe Cyclone storm (ESCS) on 13 June. The *BIPARJOY* kept meandering along north-northwest course until 14 June; thereafter it recurved towards northeast and weakened into VSCS on June 15. Moving further northeast ward, it made landfall at Indian Port, Jakhau, between Keti Bandar, Southeast Pakistan and Gujarat (India) on 16 June evening as a VSCS. It kept its CS strength intact and stationed over Tharparker, Sindh-Pakistan and adjoining Indian Rann of Kutch for the whole day before changing into deep depression over west Rajasthan, India. It caused severe heatwave conditions over Karachi and other adjacent districts from 09-12 June, culminating into a dust-thunderstorms and widespread

heavy rains in Southeast Sindh with light/moderate rainfall in Karachi during 13-17 June 2023. *BIPARJOY* incidentally happened to be the longest lasting (for 13 days) cyclone in the history of Arabian Sea. PMD's cyclone warning centre, Karachi monitored it from 5-17 June with conventional surface and upper air observations, satellite FY-4, NWP models (ICON, ECMWF, GFS and RSMC, New-Delhi advisories) and Doppler Weather Radar, Karachi and kept the authorities well informed. Following the PMD's alerts, the Govt authorities for the first time evacuated over 84000 people from the vulnerable coastal areas to avoid the potential human loss (source: www.pdma.gos.pk).

TC TEJ

TC TEJ formed over the southwest Arabian Sea on 21 October. Tracking along northwest direction, it first intensified into a Severe Cyclonic Storm, next day into a Very Severe Cyclonic Storm and further into an Extremely Severe Cyclonic Storm. Keeping its northwest course, it crossed the Yemen coast as a Very Severe Cyclonic Storm. Although the TC TEJ was far away from Pakistani coast but due to its presence and track along the Metarea IX, PMD closely monitored it and issued nine alerts until it crossed the Yemen coast.

Severe Weather (Flood) Monitoring

PMD monitors the other severe weather phenomena like flood, drought, heatwave, heavy rains and GLOF with the network of 110 Meteorological data stations, 334 RG (Rain Gauge)stations, 85 AWSs, 34 Agromet stations, 28 Pilot Balloon Observatories (PBO), 7 Weather Surveillance Radars (with 2 DWR) installed across the country besides FY-4 satellite products. The Numerical Weather Prediction (NWP) products from the models ICON, ECMWF, GFS and JMA are also used for the purpose. For riverine flood, there are additional 100 AWS installed over river catchment areas, 45 Telemetric stations and 130 water discharge data sites (maintained by the WAPDA, water and power development authority, and Irrigation department) whose data are incorporated into a flood routing model to generate the flood alerts and warning.

Drought Monitoring,

For drought monitoring the:

- i. Meteorological Indices (Cumulative Precipitation Index, Percent of Normal of Rainfall, SPI (Standard Precipitation Index), Length of dry period, Soil moisture anomaly and monthly precipitation/soil moisture outlook),
- ii. Satellite Indices (Normalized Difference Vegetation Index, NDVI, Temperature Vegetation Dryness Index, TVDI and Land Surface Temperature LST),
- iii. Water availability in reservoirs and
- iv. Field reports are used. Based on these indices, the drought bulletins, reports, advisories and alerts are issued on weekly, fortnightly, monthly & quarterly basis.

GLOF Monitoring

Meteorological & Geomorphological based GLOF alerts area issued considering the

- i. Expected Precipitation events,
- ii. Persistent high temperature over couple of days,
- iii. Persistent high temperatures followed by rain spells in following days and
- iv. Monitoring the fluctuation in the discharge from Lake level (with river and lake level sensors installed).

Heatwave

Following the WMO criteria, heatwave is when maximum temperature of a place rises 5°C above average temperature for consecutive 5 days. Since 2015 killer heatwave of Karachi, a new criteria is being followed as:

- Hot Day: $T_{max} = >35^{\circ}\text{C}$ but $< 40^{\circ}\text{C}$
- Heatwave:
 - i. $T_{max} = >40^{\circ}\text{C}$
 - ii. Departure from Normal = 5-6°C, persisting for at least 3-days
- Severe Heatwave:
 - i. $T_{max} = >40^{\circ}\text{C}$
 - ii. Departure from Normal = 7°C or more, persisting for at least 3-days

4.3.3 Country report of Myanmar by Dr. Tin Mar Htay.

Myanmar delegate presented about detail information of Cyclonic Storm during 2022 June to 2023 October. Firstly, she introduced classification of tropical cyclone of Myanmar with the wind speed and and she explain the check list for tropical cyclone and TC monitoring of Myanmar, Department of Meteorology and Hydrology. And then she explained the detail of CS information: during June to December of 2022, totally 12 times low pressure areas were formed over the Bay of Bengal. Out of them, some further intensified into five Depressions, one Deep Depression, one Cyclonic Storm and one Severe Cyclonic Storm. Almost all cyclone during June to December were not directly affected to Myanmar. All were landfall over India and Bangladesh coasts, so she said during this time Myanmar got some rainfall amount over Northwest coast of Myanmar. And then she said that for 2023 Jan to October period: the total frequency of low pressure areas over the Bay of Bengal were (13), and it were further intensified into one Well Marked Low Pressure Area, one Depression, one Deep Depression, one very severe cyclonic storm and one Extremely Severe Cyclonic Storm. She said that one deep depression, ESCS 'MOCHA' and VSCS 'HAMOON' were effected to Myanmar costs and the new recorded were observed at (29) stations the whole Myanmar area. She explain about the severe weather monitoring and forecasting of Myanmar, DMH. DMH also issued related warning before the significant weather conditions. There was (26) times significant weather events all over the country during January to October 2023. She also explain about the communication and co-ordination with national

and international organization and training and research activities DMH.

4.3.4 Summary Report of the Thai Meteorological Department, Thailand

• Overview of Thailand

Thailand is located in the central Indo-China Peninsula of Southeast Asia between the Bay of Bengal, the North Indian Ocean, and the South China Sea.

The country is under the influence of:

- SW monsoon in rainy season (mid-May to mid-Oct);
- NE monsoon in the winter time (mid-Oct to mid-Feb)
- Tropical Cyclone (TC) from both sides of the Bay of Bengal and the South China Sea impact on Thailand.

Tropical cyclones in the Bay of Bengal have a significant impact on Thailand, with the highest frequency occurring in May and November. The southern part of Thailand is at risk of facing tropical cyclones during the period from October to January, especially those originating in the South China Sea and crossing through Thailand towards the Bay of Bengal.

• Key Activities and Technical Components of Meteorology

The Technology System Concerning to Warning System in the Thai Meteorological Department (TMD), together with the Instrument and observing system, weather forecasting and NWP system, Aeronautical Met observing and forecasting, marine observing and forecasting, Earthquake, data and telecommunication, and data and information services system. The Thai Meteorological Department (TMD) has implemented and provided alerts/warnings on severe weather in CAP format since 2019 and has participated in the RAI pilot to enhance the Meteorological Disaster Risk Reduction Capability. During, 2020 - 2021, TMD continued to provide warnings on severe weather in CAP which have been linked and made available on the GMAS-A platform. The warnings and alerts in the CAP format have been disseminated immediately and updated twice a day if events comply with TMD's criteria. TMD has also improved our website to display the locations of disseminated CAP warnings and alerts on the map (<https://www.tmd.go.th/en/CAP>).

• TC monitoring and forecasting

From October 2022 to 19 December 2023, two Tropical Clones over the Bay of Bengal affected/impacted Thailand but not directly. However, tropical cyclones, originating over the Bay of Bengal, Cyclonic Storm named "SITRANG" in October 2022 and Extremely Severe Cyclonic Storm "MOCHA" (01B) in May 2023 had some effects on rainfall in Thailand during that time. These caused strong sea and wave heights in the Andaman Sea and there was heavy to very heavy rain in the upper part of Thailand.

The aspects of the early warning system for Tropical Cyclones have been standardized in the document "SOP" for Cyclone Warning in the TMD. The TMD

uses input data from observation data, GTS, satellite data, radar network, AWS, and National Hydro Informatics and Climate Data Center, Thailand (Hydro and Agro Informatics Institute (HAI), Royal Irrigation Department (RID), Water Resource Department (WRD), etc.) then into the forecasting process by analyzing the weather maps, and cloud satellite images with their application platform, GsMAP, and radar composite together with NWP products and ultimately the weather forecast products, Met alarm guidance, and advisory and warnings which are then provided to the public. In addition, TMD also generates storm track forecast maps using the TMD-WRF model and HimawariRequest from the Japan Meteorological Agency (JMA) for fulfillment.

For the Tropical Cyclone warning in Thailand Standard Operation Procedure (SOP), In the event of a developing low-pressure system intensifying into a tropical depression over the Bay of Bengal, and anticipating potential impacts on Thailand. A three-day advance warning will be issued and urge the public to stay informed, and TMD will closely monitor the situation.

- For Severe weather monitoring and forecasting

The TMD utilizes the GEO (Geostationary Earth Orbit) satellites for severe weather and TC monitoring and forecast by using RDCA (Rapidly Developing Cumulus Areas) technique with the collaboration and support from the JMA, and issuing warnings and producing the risk map area for severe weather events. Moreover, TMD also uses satellite data from GsMAP to display hourly and 24-hour cumulative rainfall estimation (Quantitative Precipitation Estimation, QPE) for the early warning system.

- Warning communication and coordination

Actions of the TMD for monitoring storm and severe forecasting, TMD provides weather warnings to the public and sends information to relevant agencies, social media, Line Alert, TMD official website (www.tmd.go.th), TMD weather radio, and Hotline 1182. The TMD also established a storm monitoring center at the headquarters and communicated via video conference system with the regional centers, provincial stations, and coordination of relevant agencies. The flow chart below shows the SOP process of normal weather conditions and severe weather conditions with the Coordination of relevant agencies.

TMD closely cooperates with the Office of National Water Resources (ONWR) of Thailand is the main organization that systematically regulates and manages the policies of integrated national water resource management. The National Water Administration Center (NWAC) was established under ONWR to monitor and integrate coordination on water situation with 38 water-related agencies, to make plans and preparations for dealing with floods and drought situations. The Royal Irrigation Department (RID) During the rainstorm-flood events, the Thai Meteorological Department (TMD), ONWR, and Royal Irrigation Department (RID) took effective measures to enhance weather and flood forecasting and early warning for disaster prevention and mitigation. Together with the Department of Disaster Prevention and Mitigation (DDPM) by the National Disaster Warning Center (NDWC) has implemented the following

activities on Disaster Risk Reduction (DRR).

The ONWR followed up on the Weather Advisory from the TMD and integrated operations with related government agencies under the NWAC to carry out the measures of preparation for the rainy season, to monitor rain forecast, especially about the storms, to prepare water traffic planning based on the severity of the disaster, focusing on risk monitoring and plans to support the situation in risk areas whole the country. In 2022-2023, the DDPM installed telemeters to collect weather data or "telemeters" at 555 points in risk-prone areas of Thailand, developed an information system to support analysis and decision making or the Decision Support System (DSS) by improving the model of the disaster forecast analysis system. In addition, the DDPM also implemented the Cell Broadcast System (CBS) to enhance the public warning capacity to the public by making connections coordinated with the Office of The National Broadcasting and Telecommunications Commission (NBTC), related public and private sectors such as the TMD, National Hydro-informatics Data Center (NHC), the RID, ONWR, National Telecom Public Company Limited (NT), and leading mobile network service providers. The DDPM Notification and Warning Dissemination Process.

4.3.5 Summary of Country Presentation of Oman by AHMED GHAWAS

The Oman Meteorological Presentation was presented and reviewed in three parts.

Part I :reviewed the meteorological centers in Oman and TC , Severe Weather & Tsunami Monitoring and Forecasting, and then the program launched by Oman Meteorology for development and modernization. The presentation included ways of communication and cooperation between Oman Meteorology stakeholders and the public.

Part II : reviewed Some extreme cases that generated some rare phenomena and it have become a challenge in the region.

Part III :Cyclone Tij, which affected Oman indirectly, was reviewed. The methods of monitoring, analysis used by Oman Meteorology and the methods of publishing bulletins and warnings to everyone, especially to the public, were published in several languages, especially the languages of foreigners residing in Oman using different ways such as social media platforms and they are summarized in easy ways such as infographics supported by appropriate images and satellite images... etc.

Part I :Introduction to Oman Meteorology

- There are two Meteorological centers in the Sultanate of Oman
 - 1- The main center (National Multi Hazards Early Warning Center) was launched in 2015.
 - 2- A regional center in the south of Oman, Salalah.
- Oman Meteorology holds an ISO certificate to achieve international standards for both the World Meteorological Organization and the Civil Aviation Organization.
- Oman Meteorology launched a three-year program under the name Muzn to develop meteorology in all aspects.
- Oman Meteorological systems and devices.
- Oman Meteorology works to communicate and cooperate on three levels to deliver its services :-
 - On the practical level, Meteorology cooperates with the system of the National

Committee for Managing Emergency Situations, as the Early Warning Center is one of the members of this system, and with the stakeholders.

- Omani Meteorology launches its services through social media platforms attractively and easily, which achieves the highest and shortest ways to communicate information, especially about early warning.
- Regular Media.

Part II :Severe Weather

- Some of the extreme cases that generated some rare phenomena in the region were briefly reviewed, and have become a challenge in the region.
- Tornado on April 22, 2023.
- Very heavy rain in a short time in the city of Salalah, November 10, 2023

Part III :Tropical Cyclone Tej

- Omani Meteorology deals with tropical conditions with a clear procedures guide published for the public.
- The National Multi Hazards Early Warning Center holds a meeting at the center, and via video confers with the regional center and weather forecasters, where their three main teams provide a daily briefing.
 - NWP Team.
 - Remote Sensing Team.
 - Synoptic Team.
 - Oman Meteorology 3 R

(Right information at the Right Time for the Right decision).

- Oman Meteorology works to communicate and cooperate on three levels to deliver its services.
 - On the practical level, meteorology cooperates with the National Committee for Emergency Management, as the National Early Warning Center is one of the members of this system and a strategic partner.
 - Oman Meteorology launches its services through social media platforms attractively and easily, which achieves the best and shortest ways to convey information, especially regarding early warning.
- The way Oman Meteorology dealt with Tropical Cyclone Tej.
- Tropical Cyclone Tej Time Table.
- The various methods used by Oman Meteorology to publish bulletins and warnings to everyone, especially to the public.
- Examples of Warnings have been published in several languages, especially for foreigners residing in Oman, and are summarized in easy ways such as an infographic supported by pictures of the occasion, satellite images, etc.
- Media communication.
- Reviewed the development of Cyclone Tej in detail and the remarkable movement and development that was observed.
- Review the graph data in areas that are affected
 - Rain.
 - Maximum winds.
 - Atmospheric pressure.

4.3.6 Country report of UAE

Infrastructure

The Nation Center Of Meteorology in UAE has presented the infrastructure, which includes more than 140 Automatic Weather Stations, 7 Weather Radar, 31 Air Quality Stations, 1 Ozone Monitoring Station, 4 satellite images from 4 different sources, 2 Upper-Air (Radiosonde), 2 Wind Profilers and 1 Lightning Detection Station all those information and data send to one a Unified data based and distributed and feeding the different services need to provide.

Numerical Weather Prediction:

The NCM runs 4 different NWP (COSMO- WRF GFS – WRF ECWF – Watch III) 4 times a day, up to 10 days forecast, and up to 1 km resolution.

Meteorological Services

The Meteorological services are provided to more than 200 destinations locally. Other services are also provided globally.

NCM develops several mobile applications, web portals, and websites targeting a wide range of customers with innovative ideas.

Disaster Risk Reduction

NCM collaborates and coordinates with the MOI and NCEMA, the NDMO in the UAE. The Natural Disasters Response Plan is activated based on the severity of the situation. NDMO can take action if needed using Early Warning System (EWS).

Tropical Cyclone Biparjoy

On 13 – 14 June 2023, the east coast of UAE was affected by a long swell with a wave period reaching 10 seconds. The wave height offshore was 2.5 meters. The Tide during the high tide period was 2.8 meters. The estimated wave setup reached 0.6 meter, which led to inundation over some beaches and coastal areas.

4.3.7 :Country report of IRAN

A presentation was made on TC monitoring and forecasting, severe weather monitoring and forecasting, Warning communication and co-ordination by I.R. Meteorological Organization of Iran.

The presentation covered the three parts viz., (i) Weather Forecasting System including Data and Information Receiving & Tools and Production, (ii) Information Dissemination and Early Warning System and (iii) Recommendations to Enhance Capacities

The Main Natural Disaster in IRAN are : Flood, Flash Flood, Storm Surge, Strong wind and lightning.

5 COORDINATION WITH OTHER ACTIVITIES IN THE PANEL REGION

5.1. Within WMOTropicalCycloneProgram

The Panel will be presented with a summary report on the status of implementation of the Tropical Cyclone Program (TCP) with a focus on its relevance to the Panel. This summary report will be submitted to the Panel in a document to be prepared by WMO Secretariat, which will provide an overview of the whole range of activities being conducted under TCP, including activities in other tropical cyclone areas. The Panel is invited to comment on the activities within TCP and make proposals for further development of the program and its closer linkage with the Panel.

Recommendation – ESCAP

ESCAP proposed to align its ongoing activity on a regional strategy to early warnings for all in collaboration with PTC secretariat to support PTC members. ESCAP suggested reviving PTC working groups and taking up demonstrative pilot on loss and damage due to the tropical cyclones in PTC region.

5.2 With ESCAP

The Panel presented with a summary report by ESCAP on their coordinated activities and plans, with particular relevance to the Panel Members, in particular,

- 5.2.1 SSOP III implementation in PTC member Countries,
- 5.2.2 Impact-based forecasting and,
- 5.2.3 A brief of ESCAP Multi-donor Trust Fund – prospects from PTC member Countries

6 REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN

The Panel examined the draft of the updated Operational Plan to be submitted by the rapporteur to the session. The review considered the important role of the RSMC New Delhi and the discussions under agenda item 4. The Panel also considered experiences during the past cyclone seasons and suggestions from Members that may lead to changes in the arrangements set out in the Operational Plan and improvements in the operational system at regional and national levels.

Mrs. Monica Sharma, Scientist-D, RSMC New Delhi, the Rapporteur for 2023 Edition of TCP-21 presented the Tropical Cyclone Operational Plan (TCP-21) draft edition 2023 on 21st December, 2023 during PTC-50 meeting as the rapporteur. The draft report was shared with all members on 23rd August. Updated TCP-21 report was shared with WMO on 18th December. She thanked all the Member countries for their valuable inputs for updating of Tropical Cyclone Operational Plan. The presentation mainly highlighted the initiatives taken by countries for the TCP-21 (edition 2023) and improvements in observations, modeling, warning services and dissemination mechanism of the countries during 2023.

The PTC appreciated Mrs. Monica Sharma for her contribution as a Rapporteur for TCP-21, 2023 edition. Also PTC requested Mrs Sharma to continue as Rapporteur for TCP-21 Tropical Cyclone Operational Plan for the year 2024.

Decision taken under the Action point under the item 6 : As the PTC Secretariat is in place the need of having a program towards the developmental activities of the PTC was felt. In this regard during the next session of PTC (PTC-51), PTC Secretariat will prepare and make a presentation on “Annual Operation Plan” and 4 Years coordinated Plan. **(Action:**

WMO/PTC Secretariat).

7. PTCSECRETARIAT

- PTCSecretariat hosting.
- PTC logo

Decision regarding the PTC Secretariat hosting

Based on the decision taken during last session, Chairman PTC sent the invitation to PTC member countries calling for hosting PTC Secretariat for the period from 2024 to 2027(4 years). The copy of the letter is given in Annexure 1. The conditions for hosting the secretariat as mentioned in the letter issued to the PRs are also given in Annexure 2. Responding to this letter, PR of Thailand expressed that they are not ready to host the PTC secretariat (Annexure 3a). The PR of Myanmar informed that they don't have expertise to host the secretariat (Annexure 3b). The PR of Pakistan informed that they are hosting the PTC Secretariat since 2004 and if given the opportunity can rehost the PTC secretariat providing all the required facilities (Annexure 3c). The PR of India informed that they agreed in principle to host the secretariat and all facilities as required can be provided (Annexure 3d). WMO representative presented the status to the PTC. The PTC discussed in details about the terms of references for hosting the PTC secretariat and agreed upon the TOR as given in Annexure 4.

The PTC requested all the representatives to all the member countries about their willingness to host the PTC secretariat. The members were asked to give their choice to elect one from India and Pakistan. The majority of the members elected India for the new Secretariat of the WMO/ESCAP Panel on Tropical Cyclones (PTC) over the Bay of Bengal and the Arabian Sea for next 4 years from 2024-2027.

Terms of reference for the PTC Secretariat are given in Annexure 5.

The PTC appreciated Government of Pakistan for having hosted the Secretariat since 2004 and provided support to the PTC. The PTC congratulated Govt. of India for hosting the PTC Secretariat during 2024-27. In this regard, a formal letter followed by host agreement from the Chair of PTC will be addressed to the PR of India to take the charge of the PTC Secretariat for the period of 2024-2027. The host agreement will be signed by the Host Country (India) and the Chairman of the PTC.

Dr. Mrutyunjay Mohapatra, Director General of Meteorology, IMD thanked all the 13 members of PTC, for electing India to host the PTC Secretariat during 2024-27.

Documents related to the past activities, correspondence etc. of the PTC secretariat and the TOR will be communicated to New PTC Secretariat. (Action by WMO and the outgoing PTC Secretariat)

The decision regarding the PTC Logo

To commemorate 50 years of PTC, it was decided in PTC 49 Session followed by the meeting of the organizing committee constituted thereof *Annexure9 to invite the proposed logo from the PTC members. RSMC New Delhi circulated the Action Points to members on..... The sample logos were received from the members and circulated to the PTC

members by RSMC. The proposed logos were presented by RSMC in the 50th Session of PTC. A dedicated Logo to commemorate 50 years of PTC was finalized and approved by the PTC and is given below. This Logo will be used for next one year (till December 2024).



The PTC Secretariat will propose a permanent logo based on wide circulation to the members of PTC and their inputs and suggestions. That will be presented in the 51st Session of PTC for consideration. (Action: WMO/PTC Secretariat).

8. SUPPORT FOR THE PANEL'S PROGRAMME

8.1 The Panel's Trust Fund

The Panel will discuss details on the Panel's Trust Fund.

8.2 Resources and Support

The Panel will review the resources currently available from all sources to support its program of activities, both with regards to the contributions made by Member themselves and external support available from a variety of sources such as WMO/VCP, WMO Regular Budget, ESCAP, RIMES, bilateral assistance, etc. and discuss potential external resources/donors.

Agenda item 8: Support for the Panel's programme from ESCAP

ESCAP suggested the PTC secretariat to conceptualize and develop Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System. This should be an effort for resource mobilization to support related PTC activities through the ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness.

ESCAP informed supporting the RIMES to 'Enhance Weather and Climate Resilience in RIMES Member States through Capacity Building on Impact Forecasting'. This is leading to the development of an online learning platform for IBF to support EW4All in PTC members. This activity was supported by the ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness.

9. OTHER MATTERS

Any items of business requiring the attention of the Panel, but not covered by other agenda items, were considered. The following two items are considered,

9.1 EW4ALL

9.2 Application in tropical cyclones

10 HOSTING ARRANGEMENT FOR FUTURE ANNUAL SESSIONS.

By convention, annual meetings of the Panel were normally hosted on a rotating basis. To facilitate Members to make early decisions and preparation, a sequence of hosting countries in alphabetical order. The final arrangements will be confirmed in consultation with the host country, PTC Secretariat, WMO and ESCAP.

Decision regarding Hosting arrangement for future annual sessions

Representative of Qatar confirmed to host the 51st session of PTC in Qatar tentatively in April 2024. The subsequent sessions PTC-52 will be held in Iran in 2025. Thereafter, the subsequent Sessions will be hosted by member countries in alphabetic order of the country names as mentioned in Table 1. Accordingly, PTC-53 will be held in Bangladesh in 2026. It was suggested that these PTC sessions after 2024, may be conducted in February/March so that the annual plan can be discussed well before the commencement of the cyclone season over the Bay of Bengal and the Arabian Sea. **(Action : WMO/PTC Secretariat).**

11. ADOPTION OF THE REPORT

The report of this session will be submitted for adoption by the Panel.

11.1 The New PTC Secretariat under the item no 7:

Based on the decision taken during last session, Chairman PTC sent the invitation to PTC member countries calling for hosting PTC Secretariat for the period from 2024 to 2027 (4 years). The copy of the letter is given in Annexure 1. The conditions for hosting the secretariat as mentioned in the letter issued to the PRs are also given in Annexure 2. Responding to this letter, PR of Thailand expressed that they are not ready to host the PTC secretariat. The PR of Myanmar informed that they don't have expertise to host the secretariat. The PR of Pakistan informed that they are hosting the PTC Secretariat since 2004 and if given the opportunity can rehost the PTC secretariat providing all the required facilities. The PR of India informed that they agreed in principle to host the secretariat and all facilities as required can be provided. WMO representative presented the status to the PTC. The PTC discussed in details about the terms of references for hosting the PTC secretariat and agreed upon the TOR.

The PTC requested all the representatives to all the member countries about their willingness to host the PTC secretariat. The members were asked to give their choice to elect one from India and Pakistan. The majority of the members elected India for the new Secretariat of the WMO/ESCAP Panel on Tropical Cyclones (PTC) over the Bay of Bengal and the Arabian Sea for next 4 years from 2024-2027.

The PTC appreciated Government of Pakistan for having hosted the Secretariat since 2004 and provided support to the PTC. The PTC congratulated Govt. of India for hosting the PTC Secretariat during 2024-27. In this regard, a formal letter followed by host agreement from the Chair of PTC will be addressed to the PR of India to take the charge of the PTC Secretariat for the period of 2024-2027. The host agreement will be signed by the Host Country (India) and the Chairman of the PTC.

Dr. Mrutyunjay Mohapatra, Director General of Meteorology, IMD thanked all the 13

members of PTC, for electing India to host the PTC Secretariat during 2024-27.

Documents related to the past activities, correspondence etc. of the PTC secretariat and the TOR will be communicated to New PTC Secretariat. (Action by WMO and the outgoing PTC Secretariat)

11.2.It was decided that the Tropical Cyclones Forecasters Attachment Training Programme, 2024 will be conducted by RSMC, New Delhi in hybrid mode.**(Action :RSMC New Delhi/WMO)**

11.3. A Special issue of journal “TCRR” will be brought out covering the articles presented by each speaker of the lecture series conducted by RSMC, New Delhi during August-November, 2023. Some additional articles from the experts will be invited for inclusion in this special issue. RSMC, New Delhi will initiate the action in this regard. **(Action :RSMC, New Delhi/WMO)**

11.4APIs of tropical cyclone track and intensity forecast upto 5 days will be provided by RSMC New Delhi to all member countries. **(Action: RSMC New Delhi)**

11.5. PTC requests that ICAO and IOC representatives may be invited to PTC Session.**(Action : WMO/PTC Secretariat)**

11.6.PTC encourages the Members to make more contribution to PTC Trust Fund**(Action : By all member countries)**

12 CLOSURE OF THE SESSION

This session is closed on 23 December 2023.

DAILY PROGRAMME

Day1: Tuesday – 19th December 2023

09:30–10:15	Registration
	Item1: Organization of the session Item 1.1: Opening of the session (See separate programme)
10:30–11:40	Opening Ceremony
	<ul style="list-style-type: none"> • H.E. Mohammed Bin Thamer Al Kaabai, Minister of Transportation and Telecommunications. • H.E Dr Abdulla Ahmed Al Mandous, President of WMO- Director General, National Center of Meteorology-UAE • H.E Dr. Wenjian Zhang, Assistant Secretary-General-WMO • Dr. Mrutyunjay Mohapatra, The Third Vice-President of WMO • Dr Ayman Salem Ghulam, Chairperson of WMO/ESCAP Panel on Tropical Cyclones, Chief Executive, National Center of Meteorology- Saudi Arabia
	Group Photo
11:40–12:00	Coffee Break
	Session 1
12:00–13:00	<ul style="list-style-type: none"> • Mr. Khalid Yaseen, Director of Bahrain Meteorological Directorate. • Dr. Taoyong PENG, Head, DRR Technical Development (DTD) Division • Dr. Sandy Srivastava, Chief, Disaster Risk Reduction
13:00–14:00	Lunch Break “Baharat Restaurant-LeMERIDIEN City Center”
	Session 2
14:00–15:45	The PTC-50 will start with a one-day technical conference to exchange new scientific and technical developments (see separate programme) : Considered as item 1.5.
15:45–16:00	Coffee Break
	Session 3
16:00–17:30	Continuation of the technical conference

Day2:Wednesday–20thDecember2023

Session1	
09:00–10:30	Item 1.2: Election of theChairperson and Vice-chairperson Item 1.3: Adoption of the agenda Item1.4:Workingarrangement
10:30–11:00	CoffeeBreak
11:00–13:00	Item2:Follow-upactionsonPTC-49 Item3:Reportofthechairpersonofthepanel
13:00–14:00	LunchBreak“BaharatRestaurant-LeMERIDIENCityCenter”
Session2	
14:00–16:00	Item 4: Review of the 2022 and 2023 Cyclone Seasons Item4.1:ReportofRSMCTropicalCyclonesNewDelhi Item4.2:ReportsofMembersontheimpactoftropicalcyclones
16:00–16:30	CoffeeBreak
Session3	
16:30–17:30	Continuethetechnicalconference

Day3:Thursday–21stDecember2023

Session1	
09:00–11:00	Item5: Coordinationwithotheractivitiesinthe Panelregion Item5.1: CoordinationwithinWMOTropicalCycloneProgramme Item 5.2: With ESCAP
11:00–11:30	CoffeeBreak
11:30–13:00	Item 6: Review of the tropical cyclone operational plan Discussions will focus on a review of the Tropical Cyclone Operational Plan for the Bay of Bengal and the Arabian Sea. In doing so, the Panel may wish to examine the draft of the updated Operational Plan to be submitted by the rapporteur to the session. The review would take into account the important role of the RSMC New Delhi and the discussions under agenda item 4. The Panel may also consider experiences during the past cyclone seasons and suggestions from Members that may lead to changes in the arrangements set out in the Operational Plan and improvements in the operational system at regional and national levels.
13:00–14:00	LunchBreak“BaharatRestaurant-LeMERIDIENCityCenter”
Session2	

14:00–15:00	Item7: PTCSecretariat <ul style="list-style-type: none"> • PTC Secretariat hosting. • PTC logo
16:00–16:30	CoffeeBreak
	Session3
16:30–17:30	Continuethetechnicalconference

Day4:Friday–22ndDecember2023

	Session 1
09:00 – 10:30	Item 8: Support for the panel's programme Item 8.1: The Panel's Trust Fund Item 8.2: Resources and Support
10:30 – 11:00	Coffee Break
11:00 – 13:00	Item 9: Other Matters Item 9.1 EW4ALL Item 9.2 Other presentations left over from technical conference
13:00 – 14:00	
14:00 – 16:00	9.3 Other issues that maybe raised during the session.
16:00 – 16:30	Coffee Break
	Session 3
16:30 – 17:30	Continue the technical conference

Day5:Saturday–23rdDecember2023

	Session1
09:00–10:30	Item10:Hostingarrangementforfutureannualsessions.
10:30–11:00	CoffeeBreak
11:00–13:00	Item11:Adoption of the report
13:00–14:00	LunchBreak“BaharatRestaurant-LeMERIDIENCityCenter”
	Session2
14:00–16:00	
16:00–16:30	CoffeeBreak
16:30–17:30	Item 12: Closing Ceremony