Bio Data

1.	**Name**	**Dr. Mrutyunjay Mohapatra**
2.	**Date of Birth**	**12th August, 1965**
3.	**Present Affiliation**	**Director General of Meteorolology,** **India Meteorological Department,** **Government of India**
4.	**Phone**	**011-24611842**
5.	**E mail**	**directorgeneral.imd@imd.gov.in, dgmmet@gmail.com,** **m. mohapatra@imd.gov.in**
6.	**Education**	**M.Sc. (Physics) and Ph.D (Physics)**
7.	**Professional Training details**	

Organization	Period		Details of Training
	From	To	
IMD, Pune	20 Oct. 1992	19 Oct. 1993	Meteorologist Gr II Training on General Meteorology (Weather forecasting)
IMD, New Delhi	12 Sep. 1994	23 Sep. 1994	Advance Refresher Course on Satellite and Radar input for cyclone warning
IMD, Pune	15Jan. 1996	19 Jan. 1996	Advance Refresher Course on Long Range Forecasting and Climate Change
Centre for Atmospheric Sciences, IIT, Delhi	08 Apr. 2002	04 May 2002	Third SERC School on Numerical Weather Prediction (NWP) on Parameterisation of physical processes
-Do-	14 Apr. 2003	10 May 2003	Fourth SERC School on NWP on Process modeling
Central Water Commission, Govt. of India, Bhubaneswar	9 Nov. 2003	13 Nov. 2003	Training workshop on „Design Flood Estimation for Water Resources Projects“
Administrative Staff College of India, Hyderabad	01 Aug. 2005	09 Sep. 2005	Advanced Techno-Management programme for Scientists and Technologists on Various theoretical aspects of management
Meteo-France and Meteo-France International, Toulouse, France	31 Aug. 2009	25 Sep. 2009	Weather forecasting for IMD and Synergie System Forecasters Factory Training on Application of satellite, radar and NWP in weather forecasting, nowcasting and heavy rainfall warning
NationalHurricane Center (NHC), NOAA, Miami, Florida, USA	21 Mar. 2011	01 Apr. 2011	RA IV Training Workshop on Hurricane Forecasting and Warning and Public Weather Services

8.	**Employment records (in chronological order starting with the first job)**				
	Name and address of employer/institution	**Period**		**Details including designation and responsibility area**	
		From	**To**	**Designation of post held and scale of pay**	**Responsibility area**
	Interim Test Range (ITR), Defence Research and Development Organisation (DRDO), Chandipur, Balasore, Orissa	29. 02. 1988	04. 03. 1990	Junior Scientific Assistant	Fiber Optic Communication and Data Management
	D. K. College, Jaleswar, Balasore, Orissa	05. 03. 1990	17. 10. 1992	Lecturer in Physics,	Teaching in undergraduate classes
	India Meteorological Department (IMD), Pune	20. 10. 1992	19. 10. 1993	Meteorologist Gr. II Trainee	Training
	Meteorological Centre, and Agromet Research Unit, IMD, Bangalore	20. 10. 1993	14 06.1998	Meteorologist Gr. II	Weather forecasting, Climatology, Aviation Meteorology, Agrometeorology
	Meteorological Centre, IMD, Bhubaneswar	15. 06.1998	09.12. 1998	Meteorologist Gr. II	Weather forecasting and Cyclone Warning, Climatology, Aviation Meteorology
	Meteorological Centre, IMD, Bhubaneswar	10. 12. 1998	22. 02.2004	Meteorologist Gr. I	Weather forecasting and Cyclone Warning, Climatology, Aviation Meteorology
	Regional Meteorological Centre, IMD, Guwahati	23. 02. 2004	16. 10. 2005	Director	Weather forecasting, Climatology, Aviation Meteorology
	National Weather Forecasting Centre (NWFC) formerly Northern Hemispheric Analysis Centre (NHAC), IMD, New Delhi	17. 10. 2005	30. 06. 2010	Director	Weather forecasting and Cyclone Warning,
	NWFC (Formerly NHAC), IMD, New Delhi	01.07. 2010	30.06. 2015	Scientist-E	Weather forecasting and Cyclone Warning, Disaster management.
	NWFC (Formerly NHAC), IMD, New Delhi	01.07. 2015	28. 01. 2016	Scientist-F	Weather forecasting, Numerical Weather prediction (NWP) and Cyclone Warning, Disaster management
	IMD New Delhi	29.01. 2016	31.07. 2019	Scientist-G	Weather forecasting, Numerical Weather prediction (NWP) and Severe weather warning, Disaster management
	IMD New Delhi	01.08. 2019		Director General of Meteorology	India Meteorological Department
9.	**Details of research work and publication.**	Research work and scientific publications are mainly based on weather forecasting and cyclone warning including (i) Cyclonic disturbances, (ii) Monsoonal low pressure systems, (iii) Heavy rainfall, (iv) Thunderstorm and (v) Forecast verification **Papers published in journals:106** (National=68, International=38) **Proceedings in Symposiums/Workshops/Conference:26**			

		(National = 11, International = 15) **Publication in Books:42** (National=17, International = 25) **Books edited : 20**(National = 5, International = 15) **Journals edited : 08** (National = 4, International = 4) **Journals/Books reviewed:18** National=4, International=14) **H-Index:20, I_{10}=45, RG score : 32.71** Details of research work and publications are given in **Enclosure – I**
10.	**Specialization**	Specialization in (i) Weather forecasting Services (**Enclosure II)** (ii) Project/Programme Management: No. of Projects dealt**: 7** (**Enclosure III)** (iii) Research & Development: (**Enclosure I)** (iv) General Administration & Management : Worked as (a) Head, Regional Specialised Meteorological Centre-Tropical Cyclone (RSMC) since 2008 (b) Head (Numerical Weather Prediction Division) during 2015-16 and 2018 onwards (c) Head (Services) 29 January 2016 to 31 July 2019 (d) Head of Regional Subproject Management Team of Severe weather Forecasting Demonstration Project (SWFDP)-Bay of Bengal (e) Looked after current duties of Director General of Meteorology(DGM), IMD on many occasions during leave/tour of DGM (From February 2016 to July 2019) (v) Capacity Building of IMD, MoES & WMO/ESCAP Panel region through: • Organising National/International Trainings: 22Trainings programmes organized • Organising National/International Workshops: • **11** Workshops/ conferences conducted • Delivery of **87** invited lectures during 2009-21 • Delivery of **41** assigned talks during 2009-21 • Delivery of more than **120** popular lectures • Writing of popular articles • Development of **3** Movies on IMD. • Interviews to press and electronic media on weather and climate
11.	**Significant Contributions**	**Details of Scientific contributions and societal contributions are given in Annexure-IV**
12.	**Membership of Societies**	(i) President of Indian Meteorological Society (2020-2022 (ii) Vice-President, Indian Meteorological Society (2016-18) (iii) Life Member, Indian Meteorological Society (iv) Life Member, Administrative Staff College of India Society (v) Life Member, Indian Climate Congress.
13.	**Details of awards and recognitions received**	**(a) Awards** **(i)** Honorary Doctor of Science(D.Sc.) from FM University, Balasore, Odisha-2020 **(ii)** Honorary D.Sc. from Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar, Odisha-2020 **(iii)** Fellow, Indian Meteorological Society, 2019 **(iv)** Achiever's Award-2013 for excellence in cyclone warning services to Cyclone Warning Division from India Meteorological Department **(v)** Certificate of Merit for Young Scientist Award – 2008 by Ministry of Earth Sciences, for outstanding contribution in the field of atmospheric science and technology. **(vi)** 25th Biennial Mausam Award (2008-2009) for the paper, published in MAUSAM **(vii)** Bharat Gaurav Award-2019 by Jai Bharat Foundation, Cuttack Odisha

		(viii) Felicitation by Sh. Naveen Pattanaik, Chief Minister, Odisha for outstanding contribution in disaster management **(ix)** Satyasai Samman-2019 by Satyasai Charitable and Education Trust, Odisha for distinguished contribution in cyclone forecasting and meteorological applications **(x)** Bhumiputra Samman 2020 by the Biplbi Beera Chakradhar Smruti Sansad, Ghanteswar, Odisha for Cyclone Warning Services **(xi)** Commendation certificate during 1989 from Defence Research and Development Organisation, for contribution to Integrated Guided Missile Development Programme **(xii)** Commendation Certificates-2019 and 2020 from various organizations for prediction of cyclone **(xiii)** Ganatantrik Nagarik Parishad, Bhadrak Odisha **(xiv)** Zila Biju Smriti Committee, Bhadrak Odisha **(xv)** Odisha Forum, New Delhi **(xvi)** Retired Employees Association, Bhadrak, Odisha **(xvii)** Felicitation by Utkal University in recognition to cyclone warning services **(xviii)** Felicitation by Berhampur University, Odisha for excellence in cyclone warning services ***b) Appreciations:*** **(i)** Appreciations received for improvement in cyclone and other severe weather warning services **1.** Appreciations received globally and nationally from government and non- government agencies including WMO, NDRF, IAF, State Govts for successful predicting of cyclones during 2013-2020 **2.** Publications in leading TV/News Papers of India highlighting the role of Dr M Mohapatra in improvement of cyclone warning services **3.** Documentary/interview in TV and Newspapers on life and achievements of Dr M Mohapatra **(ii)** Appreciations from WMO, NIDM, IMD for official publications **(iii)** Appreciations from WMO, IMD for delivering and organizing lectures, conference/workshop. ***c) Recognitions*** ***(1)Chairman of International Committee*** **(i)** Chairman, WMO/ESCAP Panel on Tropical Cyclones for 2017- 18. **(ii)** Chairman, Regional Sub-project Management Team of Severe Weather Forecast Programme for South Asia **(iii)** Chairman, WMO Task Team for coordination of activities in Regional Association II (Asia) **(iv)** Chairman, Executive Council, South Asia Hydrometeorological Forum, **(2) Expert Member of the International Committees** **(i)** Permanent Representative of India with WMO with effect from June, 2019 **(ii)** Member Executive Council, WMO with effect from June, 2019-23 **(iii)** Storm Surge India (SSI) group under the auspices of Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) since 2009 **(iv)** International Organising Committee (IOC) of WMO's 8th and 9th International Workshop on Tropical Cyclones

		(IWTC-9), 2014 and 2018 and WMO's 4th International Workshop on Tropical Cyclone Landfall Processes (IWTCLP-4), 2014 and 2017 **(v)** WMO's Tropical Cyclone Panel: climate impact on tropical cyclones. **(vi)** WMO Commission for Climatology (CCl): Weather and Climate Extremes evaluation committee for Weather Mortality extremes. **(vii)** WMO Executive Council of Panel of Experts on Polar and High Mountain Observations, Research Services (EC-PHORS) **(viii)** WMO Committee for deciding mortality extremes due to severe weather events. **(3) Chairman of National Committees** **(i)** President, Indian Meteorological Society since 2020, **(ii)** Vice President of Indian Meteorological Society during 2017-18 **(iii)** Chairman, Project Review Board of National Institute of Ocean Technology **(iv)** Chairman, Task Team for finalization of Meteorological Payloads of INSAT-4 satellites **(v)** Chairman, MoES Committee for development of Thunderstorm Prediction System in 2018 **(vi)** Chairman, Indian National Academy of Engineering (INAE) peer committee for technological preparedness to avoid national disruptions (weather and water related disasters) **(vii)** Chairman, Committee for revision of NDMA Guidelines for cyclone management in 2016, **(viii)** Chairman, Technical Evaluation Committee for Consultancy on National Cyclone Risk Mitigation Project ***(4) Expert Member of the National Committee*** **(i)** Committee by National Disaster Management Authority (NDMA), Government of India for preparation of Cyclone Hazard Prone Districts of India. **(ii)** Committee constituted by Ministry of Home Affairs (MHA), Govt. of India for preparation of Blue Book on lessons learnt on management of cyclones. **(iii)** Management Committee to review the progress/functioning of existing Research Chairs established in IITs/NITs on Climate Change **(iv)** Committee for development of Chennai Flood warning System **(v)** Expert Member from MoES for the Bureau of Standards Smart City **(vi)** Sub-committe for Atmospheric Applications and Research for better coordination between ISRO/DOS and ESSO-MoES in enhancing satellite data utilization for weather and climate. **(vii)** Committee constituted by Central Electricity Authority to study the causes of frequent failures of transmission towers and sub-station equipment in and around Agra region **(viii)** Cauvery Water Regulation Committee constituted by Ministry of Water Resources **(ix)** Committee constituted by NDMA for preparation of Guidelines on Thunderstorms, Squall and Lightning. **(x)** Management Committee and Chairman of the sub-

		committee on "Short and Medium range Forecast" for development of Monsoon Mission Products website and Mobile App. **(xi)** Cyclone Resistant Structure Sectional Committee (CED-57), Bureau of Indian Standards for development of guidelines for design and construction of Cyclone Shelters/Tsunami Shelters. **(xii)** Steering Committee for Common Alert Protocol (CAP) project of NDMA **(xiii)** Research Advisory Committee of INCOIS to provide the guidance for scientific research & technical activities undertaken at INCOIS during 2015-19 **(xiv)** National Coordination Committee for Polar Science Programme (NCCPSP) **(xv)** Monsoon Mission Programme, Ministry of Earth Sciences **(xvi)** Governing Council, Indian Institute of Tropical Meteorology, Pune **(xvii)** National Water Development Authority, Ministry of Jal Shakti **(xviii)** National Maritime Search and Rescue Board **(xix)** Peer Committee constituted by Indian National Academy of Engineering for technological preparedness for dealing with national disruptions. **(xx)** Research Advisory Committee, Indian National Centre for Ocean Information Services (INCOIS), Hyderabad **(xxi)** Research Advisory Committee, National Centre for Medium Range Weather Forecasting, Noida **(xxii)** Research Advisory Committee, National Centre for Coastal Research (NCCR), Chennai **(xxiii)** Research Advisory Committee, SAMEER, MEITY, Got. Of India **(xxiv)** Advisory Committee in the Centre for Ocean, Rivers, Atmosphere and Land Sciences (CORALS), IIT, Kharagpur ***(5) Recognition as Guide for research*** **(i)** Recognised as Guide for Ph. D work in • Banaras Hindu University • Amity University, Gurgaon, Haryana, • Amity University, Noida, • IIT, Delhi. **(ii)** Ph.D. Awarded/submitted: 2 and Continuing: 4 **(iii)Ph. D. Examiner** in 7 Universities/Institutes **Details are given in Enclosure-V**

Enclosure I: Publications and Research & Development

(a) Papers published in reviewed national and international journals

1. **Mrutyunjay Mohapatra and** Monica Sharma, 2021, Comparative analysis of vital parameters of extremely severe cyclonic storms Phailin & Hudhud over the Bay of Bengal, **J Earth Syst Sci**. **(Accepted)**
2. Mukhopadhyay, Parthasarathi, Peter Bechtold, Yuejian Zhu, R Phani Murali Krishna, Siddharth Kumar, Malay Ganai, Snehlata Tirkey, Tanmoy Goswami, M Mahakur, Medha Deshpande, VS Prasad, CJ Johny, Ashim Mitra, Raghavendra Ashrit, Abhijit Sarkar, Sahadat Sarkar, Kumar Roy, Elphin Andrews, Radhika Kanase, Shilpa Malviya, S Abhilash, Manoj Domkawale, SD Pawar, Ashu Mamgain, VR Durai, Ravi S Nanjundiah, Ashis K Mitra, EN Rajagopal, **M Mohapatra**, M Rajeevan, 2021, Unraveling the Mechanism of Extreme (More than 30 Sigma) Precipitation during August 2018 and 2019 over Kerala, India, Weather and Forecasting 36 (4), 1253-1273, DOI:https://doi.org/10.1175/WAF-D-20-0162.1
3. Emily Shroyer, Amit Tandon, Debasis Sengupta, Harindra JS Fernando, Andrew J Lucas, J Thomas Farrar, Rajib Chattopadhyay, Simon de Szoeke, Maria Flatau, Adam Rydbeck, Hemantha Wijesekera, Michael McPhaden, Hyodae Seo, Aneesh Subramanian, R Venkatesan, Jossia Joseph, S Ramsundaram, Arnold L Gordon, Shannon M Bohman, Jaynise Pérez, Iury T Simoes-Sousa, Steven R Jayne, Robert E Todd, GS Bhat, Matthias Lankhorst, Tamara Schlosser, Katherine Adams, SUP Jinadasa, Manikandan Mathur, **M Mohapatra**, E Pattabhi Rama Rao, AK Sahai, Rashmi Sharma, Craig Lee, Luc Rainville, Deepak Cherian, Kerstin Cullen, Luca R Centurioni, Verena Hormann, Jennifer MacKinnon, Uwe Send, Arachaporn Anutaliya, Amy Waterhouse, Garrett S Black, Jeremy A Dehart, Kaitlyn M Woods, Edward Creegan, Gad Levy, Lakshmi H Kantha, Bulusu Subrahmanyam, 2021, Bulletin of the American Meteorological Society, 1-44, DOI: https://doi.org/10.1175/BAMS-D-20-0113.1.
4. Bondyopadhyay, S., **Mohapatra, M.** & Sen Roy, S. Determination of suitable thermodynamic indices and prediction of thunderstorm events for Kolkata, India. *Meteorol Atmos Phys* **133,** 1367–1377 (2021). https://doi.org/10.1007/s00703-021-00813-1.
5. Pattanaik, D.R., Raju Mandal, R Phani, Avijit Dey, Rajib Chattopadhyay, Susmitha Joseph, AK Sahai, **M Mohapatra**, 2021, Large-scale features associated with excess monsoon rainfall over india during 2019 and the real-time extended range forecast. *Meteorol Atmos Phys* **133,** 1275–1297 (2021). https://doi.org/10.1007/s00703-021-00808-y
6. Kumar, N., **Mohapatra**, M., Dimri, A.P. *et al*. Spatial and temporal variation in daily precipitation indices over Western Himalayas. *J Earth Syst Sci* **130,** 151 (2021). https://doi.org/10.1007/s12040-021-01647-6
7. **Mrutyunjay Mohapatra**, Monica Sharma, Sunitha S. Devi, S. V. J. Kumar and Bharati S. Sabade, 2021, Frequency of genesis and landfall of different categories of tropical cyclones over the north Indian Ocean, **Mausam**, 72, 1-26.
8. Ahmed, R., **Mohapatra, M,** Dwivedi, S., Giri, R.K., Characteristics features of Super Cyclone 'AMPHAN'-Observed through Satellite images, Tropical Cyclone Research and Review,https://doi.org/10.1016/j.tcrr.2021.03.003
9. Medha Deshpande, Radhika Kanase, R. Phani Murali Krishna, Snehlata Tirkey, P. Mukhopadhyay, V. S. Prasad, C. J. Johny, V. R. Durai, Sunitha Devi and **M. Mohapatra**, 2021 "Global Ensemble Forecast System (GEFS T1534) evaluation for tropical cyclone prediction over the North Indian Ocean", Mausam, 72, 1, 119-128.
10. Soma Sen Roy, Pradeep Sharma, Bikram Sen, K.Sathi Devi, S.Sunitha Devi, Neetha K. Gopal, Naresh Kumar, Krishna Mishra, Shobhit Katyar, Surendra Pratap Singh, Shibin Balakrishnan, Charan Singh, Kuldeep Srivastava, Sonam Lotus, Surendra Paul, Bikram Singh, J.P.Gupta, S. Bandopadhyay, Ganesh Das, Anand Shankar, S.D. Kotal, H.R. Biswas, S. O'Neil Shaw, Sunit Das, Ranjan Phukan, K. Nagarathna, S. Balachandran, N.Puviarasan, S.Stella, R.Bibraj, V. K. Mini, M. Rahul, G. Agnihotri, J. Sarkar, M. Mohanty, Ved Prakash, K. Hosalikar, T. S. Nitha, M. L. Sahu, Bhawna Kumari, Anupam Kashyapi, Manmohan Singh, H. A. K. Singh, Radhey Shyam Sharma , G. N. Raha, Y. K. Reddy, K. J. Ramesh, **M. Mohapatra**, 2021, A new paradigm for short range forecasting of severe weather over the Indian region, Meteorology and Atmospheric Physics, 10.1007/s00703-021-00788-z
11. D. R. Pattanaik, **Mrutyunjay Mohapatra,** 2021, Evolution of IMD's operational extended range forecast system tropical cyclogenesis over North Indian Ocean during 2010-2020, **Mausam,** 72, 35-56
12. **M. Mohapatra**, Kumar, N., Mishra, K., S. Devi, 2021, Evaluation of heavy rainfall warnings of India National Weather Forecasting Service for monsoon season (2002–2018), 2021, **J Earth Syst Sci** 130, https://doi.org/10.1007/s12040-020-01549-z

13. **Mrutyunjay Mohapatra**, Ashim K. Mitra, Virendra Singh S.K Mukherjee, Kavita Navria Vikram Prashar, Ashish Tyagi, Atul kumar Verma, Sunitha Devi, V S Prasad, M R Raj Kumar, 2021, INSAT-3DR rapid scan operations for weather monitoring over India: A new initiative at IMD", Current Science, 120, 1026-1034.
14. Mishra, K., Sharma, M. & **Mohapatra, M**., 2021, Correction to: Performance of numerical weather prediction models in predicting track of recurving cyclone Vayu over Arabian Sea during June 2019. J Earth Syst Sci 130,. https://doi.org/10.1007/s12040-021-01583-5
15. Krishna Mishra, M. Sharma and **M. Mohapatra**, 2021, Performance of numerical weather prediction models4in predicting track of recurving Cyclone VAYU over Arabian Sea during June 2019, J. Earth Syst. Sci., 130, 1-18, https://doi.org/10.1007/s12040-020-01533-7
16. **M. Mohapatra,** D. S. Pai, A.K. Sahai, P. Mukhopadhyay, Ashis Mitra, Aarti Bandgar, C.J. Johny, D.R. Pattanaik, Divya Surendran, M. Benke, Medha Deshpande, Malay Ganai, Monica Sharma, Naresh Kumar, O.P. Sreejith, R. Chattopadhyay, R. Phani Murali Krishna, S. Abhilash, Sunitha Devi, S. Joseph, Suryachandra Rao, Sahadat Sarkar, Snehlata Tirkey, Tanmoy Goswami, and V.S. Prasad, 2020, Contribution of Monsoon Mission to Operational Advances: Short to Medium Range, Extended Range and Seasonal Forecasts, **CLIVAR Exchanges**, 79, 15-21, DOI: 10.36071/clivar.79.2020
17. **Mohapatra, M**., Monica Sharma and Sunitha Devi, 2020**,** Cyclones and Disaster Management, Journal of Governance, 22, 200-220.
18. S. D. Kotal, Soma Sen Roy, Radheshyam Sharma, **Mrutyunjay Mohapatra**, 2020, A location-specific nowcast and SMS-based dissemination system for thunderstorm and lightning warning over Jharkhand, India., Current Science, 120, 1194-1201
19. D. S. Pai, Arti Bandgar, Sunitha Devi**,** Madhuri Musale, M. R. Badwaik, A. P. Kundale, Sulochana Gadgil, **M. Mohapatra** and M. Rajeevan, Normal Dates of Onset/Progress and Withdrawal of Southwest Monsoon over India, ***Mausam,* 71,** 553-570**, 2020.**
20. U C Mohanty, **M Mohapatra** , Karumuri Ashok , R Krishnan , Jasti S Chowdary and Parthasarathi Mukhopadhyay, 2020 Indian Monsoons Variability and Extreme Weather Events: Recent Improvements in Observations and Modelling, *Proc Indian Natn Sci Acad* 86, 503-524
21. K. Singh, Panda, J. & **M. Mohapatra**, 2020 Robustness of best track data and associated cyclone activity over the North Indian Ocean region during and prior to satellite era. *J Earth Syst Sci* **129,** https://doi.org/10.1007/s12040-020-1344-x
22. SD Sanap, **M Mohapatra**, MM Ali, P Priya And D Varaprasad, 2020, On the dynamics of cyclogenesis, rapid intensiBcation and recurvature of the very severe cyclonic storm, Ockhi, J. Earth Syst. Sci., 129, https://doi.org/10.1007/s12040-020-01457-2
23. P Mukhopadhyay, R Krishnan, RS Nanjundiah, **M Mohapatra**, 2020, Prediction of Extreme Events: Current Status and Future Pathways against the backdrop of climate change, Bulletin of the American Meteorological Society, https://doi.org/10.1175/BAMS-D-20-0037.1
24. Shyama Mohanty, Raghu Nadimpalli, UC Mohanty, **M Mohapatra**, A Sharma, Ananda K Das, S Sil, 2020, Quasi-operational forecast guidance of extremely severe cyclonic storm Fani over the Bay of Bengal using high-resolution mesoscale models, Meteorology and Atmospheric Physics, 1-18
25. **M. Mohapatra** and M. Sharma, 2019, Cyclone Warning Services in India during recent years: A review, Mausam, 70, 635-666
26. S Parihar, AK Mitra, **M Mohapatra**, LS Rathore, R Bhatla, RS Singh, 2019, Use of the Moon to promote on-board calibration of INSAT-3D imager visible channel, Indian Journal of Physics 93 (10), 1241-1246
27. T. Knutson, S. Camarago, JCL Chan, K Emanuel, C H Ho, J. Kossin, **M. Mohapatra**, M. Satoh, M. Sugi, K. walsh, L.Wu, 2019, Tropical Cyclones and Climate Change Assessment: Part II, Projected Response To Anthropogenic Warning, Bulletin of the American Meteorological Society, 101, E303-E322, https://doi.org/10.1175/BAMS-D-18-0194.1
28. Soma Sen Roy, **M. Mohapatra**, Ajit Tyagi And S. K. Roy Bhowmik, 2019, A review of Nowcasting of convective weather over the Indian region, Mausam, 70, 3 (July 2019), 465-484
29. Thomas Knutson, Suzana J. Camargo, Johnny C. L. Chan, Kerry Emanuel, Chang-Hoi Ho, James Kossin, **Mrutyunjay Mohapatra**, Masaki Satoh, Masato Sugi , Kevin Walsh, Liguang Wu, 2019, Tropical Cyclones and Climate Change Assessment: Part I. Detection and Attribution, Bulletin of the American Meteorological Society, 100, 1987-2007, 10.1175/BAMS-D-18-0189.1.
30. Subimal Ghosh, Subhankar Karmakar, Anamitra Saha, Mohit Prakash Mohanty, Shees Ali, Satya Kiran Raju,

Vrinda Krishnakumar, Maneesha Sebastian, Manasa Ranjan, Behera, R Ashrit, P L N Murty, K Srinivas, B. Narasimhan, Tune Usha, M V Ramana, Murthy, P Thiruvengadam, J Indu, D Thirumalaivasan, John P. George, S Gedam, A B Inamdar , B S Murty, P P Mujumdar, **M Mohapatra**, Arun Bhardwaj, Swati Basu, 2019, Development of India‟s First Integrated Expert Urban Flood Forecasting System for the City of Chennai, Current Science, 117(5), 741-745

31. Julian Heming, Fernando Prates, Morris Bender, John Cangialosi, Phillippe Caroff, James Doyle, AnumehaDube, Ghislain Faure, Brian Howell, Yohko Igarashi, Ron McTaggart- Cowan, **Mrutyunjay Mohapatra**, Jon Moskaitis, Jim Murtha, Rabi Rivett, Monica Sharma, Chris Short, Amit Singh, Vijay Tallapragada, Helen Titley, Yi Xiao, 2019, Review of Recent Progress in Tropical Cyclone Track Forecasting and Expression of Uncertainties, Tropical Cyclone Research and Review, 8 (4), 181-218
32. K Singh, J Panda, M Sahoo, **M Mohapatra**, 2018, Variability in Tropical Cyclone Climatology over North Indian Ocean during 1891 to 2015, Asia-Pacific Journal of Atmospheric Sciences, 1-19
33. S, Parihar, AK Mitra, **M Mohapatra**, R Bhatla, 2018, Potential of INSAT-3D sounder-derived total precipitable water product for weather forecast, Atmospheric Measurement Techniques, 11, 6003-12
34. S Goyal, A Kumar, **M Mohapatra**, LS Rathore, SK Dube, R Saxena, 2017, Satellite-based technique for nowcasting of thunderstorms over Indian region, Journal of Earth System Science 126 (6), 79
35. S, Goyal, **M Mohapatra**, P Kumari, SK Dube, K Rajendra, 2017, Validation of Advanced Dvorak Technique (ADT) over north Indian Ocean, Mausam 68 (4), 689-698
36. N,Kumar, AK Jaswal, **M Mohapatra**, PA Kore, 2017, Spatial and temporal variation in daily temperature indices in summer and winter seasons over India (1969–2012), Theoretical and Applied Climatology 129 (3-4), 1227-1239
37. Pattanaik, D.R., **M Mohapatra**, AK Srivastava, A Kumar, 2017, Heat wave over India during summer 2015: an assessment of real time extended range forecast, Meteorology and Atmospheric Physics 129 (4), 375-393
38. Randall S Cerveny, Pierre Bessemoulin, Christopher C Burt, Mary Ann Cooper, Zhang Cunjie, Ashraf Dewan, Jonathan Finch, Ronald L Holle, Laurence Kalkstein, Andries Kruger, Tsz-cheung Lee, Rodney Martínez, **M Mohapatra**, DR Pattanaik, Thomas C Peterson, Scott Sheridan, Blair Trewin, Andrew Tait, MM Abdel Wahab, 2017, WMO Assessment of Weather and Climate Mortality Extremes: Lightning, Tropical Cyclones, Tornadoes, and Hail; Weather, Climate and Society 9 (3), 487-497
39. N Kumar, **M Mohapatra**, AK Jaswal, 2017, Meteorological features associated with unprecedented precipitation over India during 1st week of March 2015, Journal of Earth System Science 126 (5), 62
40. DR Pattanaik, **M Mohapatra**, 2017, Active North-East Monsoon Over India During 2015–An Assessment of Real Time Extended Range Forecast, Current Science, 112 (11), 2253-2262
41. **M Mohapatra**, B Geetha, M Sharma, 2017, Reduction in uncertainty in tropical cyclone track forecasts over the North Indian Ocean, Current Science 112 (9), 1826
42. **M Mohapatra**, VV Kumar, 2017, Interannual variation of tropical cyclone energy metrics over North Indian Ocean, Climate Dynamics, 48, 1431-1445
43. PLN Murty, J Padmanabham, T Srinivasa Kumar, N Kiran Kumar, V Ravi Chandra, SSC Shenoi, **M Mohapatra**, 2017, Real-time storm surge and inundation forecast for very severe cyclonic storm ‘Hudhud’, Ocean Engineering, 131, 25-35
44. S Goyal, **M Mohapatra**, A Kumar, SK Dube, K Rajendra, P Goswami, 2016, Validation of a satellite-based cyclogenesis technique over the North Indian Ocean, Journal of Earth System Science 125 (7), 1353-1363
45. S Goyal, **M Mohapatra**, SK Dube, P Kumari, I De, 2016, Mesoscale convective systems in association with tropical cyclones over Bay of Bengal, Natural Hazards 82 (2), 963-979
46. D.R. Pattanaik, **M. Mohapatra**; 2016; Seasonal Forecasting of Tropical Cyclogenesis over the North Indian Ocean; Journal of Earth System Science; 125, 231-250; DOI:10.1007/s12040-016-0663-4
47. M. Mandal, K. S. Singh, M. Balaji, **M. Mohapatra**; 2016; Performance of WRF-ARW model in real-time prediction of Bay of Bengal cyclone ‘Phailin’; Pure and Applied Geophysics; 173, 1783-1801, DOI:10.1007/s00024-015-1206-7
48. U.C. Mohanty, Krishna K. Osuri, Vijay Tallapragada, Frank D. Marks, Sujata Pattanayak, **M. Mohapatra**, L. S. Rathore, S. G. Gopalakrishnan, Dev Niyogi; 2015; A Great Escape from the Bay of Bengal “Super Sapphire-Phailin” Tropical Cyclone: A Case of Improved Weather Forecast and Societal Response for Disaster Mitigation; Earth Interactions; **pp;** 19(17):151104123042003. DOI:10.1175/EI-D-14-0032.1

49. T. Srinivasa Kumar, P.L.N. Murty, M. Pradeep Kumar, M. Krishna Kumar, J. Padmanabham, N. Kiran Kumar, S.C. Shenoi, **M. Mohapatra**, ShaileshNayak, Prakash Mohanty; 2015; Modeling Storm Surge and its Associated Inland Inundation Extent Due to Very Severe Cyclonic Storm Phailin; Marine Geodesy; 38(4); 345-360; DOI:10.1080/01490419.2015.1053640
50. **M. Mohapatra**, Monica Sharma; 2015; Characteristics of surface wind structure of tropical cyclones over the north Indian Ocean. Journal of Earth System Science; 124(7):1573-1598. DOI:10.1007/s12040-015-0613-6
51. **M. Mohapatra**, B. Geetha, S. Balachandran, L.S. Rathore; 2015; On the Tropical Cyclone Activity and Associated Environmental Features over North Indian Ocean in the Context of Climate Change; Journal of Climate Change,1, 1-26.
52. **M. Mohapatra;** 2015; Tropical cyclone forecast verification by India Meteorological Department For north Indian Ocean: a review; Tropical Cyclone Research and Review**,** 03, 1-14
53. **M. Mohapatra**, D P Nayak, Monica Sharma, R P Sharma, B K Bandyopadhyay; 2015; Evaluation of official tropical cyclone landfall forecast issued by India Meteorological Department; Journal of Earth System Science; 124(4), 861-874; DOI:10.1007/s12040-015-0581-x
54. **M Mohapatra;** 2015**;** Cyclone hazard proneness of districts of India; Journal of Earth System Science; 124(3), 515-526; DOI:10.1007/s12040-015-0556-y
55. Manorama Mohanty, **M. Mohapatra**, SNA Jaaffrey; 2014; Some characteristics of rainfall over major urban centres of Gujarat; Mausam; 65; 608-618
56. Krishna K. Osuri, U. C. Mohanty, Ashish Routray and **M. Mohapatra**; 2013; Real-Time Track Prediction of Tropical Cyclones over the North Indian Ocean Using the ARW Model; Journal of Applied Meteorology and Climatology; 52(11), 2476-2492
57. **M. Mohapatra**, B K Bandyopadhyay, D P Nayak; 2013; Evaluation of operational tropical cyclone intensity forecasts over north Indian Ocean issued by India Meteorological Department; Natural Hazards; 68(2); 433-451; DOI:10.1007/s11069-013-0624-z
58. **M. Mohapatra**, D P Nayak, R P Sharma, B K Bandyopadhyay; 2013; Evaluation of official tropical cyclone track forecast over north Indian Ocean issued by India Meteorological Department; Journal of Earth System Science; 122(3); 589-601; DOI:10.1007/s12040-013-0291-1
59. D.R. Pattanaik, **M. Mohapatra**, B. Mukhopadhyay, AjitTyagi; 2013; A preliminary study about the prospects of extended range forecast of tropical cyclogenesis over the north Indian Ocean during 2010 post-monsoon season; Mausam; 64(1);171-188.
60. T.N. Jha, **M. Mohapatra**, B.K. Bandyopadhyay; 2013; Estimation of intensity of tropical cyclone over Bay of Bengal using microwave imagery; Mausam; 64(1);105-116.
61. Suman Goyal and **M. Mohapatra**; 2013; Comparison of best track parameters of RSMC, New Delhi with satellite estimates over north Indian Ocean; Mausam; 64; 25-34.
62. **M. Mohapatra**, D.R. Sikka, B.K. Bandyopadhyay, AjitTyagi; 2013; Outcomes and challenges of Forecast Demonstration Project (FDP) on landfalling cyclones over Bay of Bengal; Mausam; 61(1):01-12.
63. **M. Mohapatra**, G. S. Mandal, B. K. Bandyopadhyay, AjitTyagi, U. C. Mohanty; 2012; Classification of cyclone hazard prone districts of India. Natural Hazards; 63(3); 1601-1620; DOI:10.1007/s11069-011-9891-8
64. Krishna K. Osuri, U. C. Mohanty, A. Routray, Makarand A. Kulkarni, **M. Mohapatra;** 2012; Customization of WRF-ARW model with physical parameterization schemes for the simulation of tropical cyclones over North Indian Ocean; Natural Hazards; 63(3); 1-23; 1337-1359; DOI:10.1007/s11069-011-9862-0
65. Geeta Agnihotri, **M. Mohapatra;** 2012; Prediction of occurrence of daily summer monsoon precipitation over Karnataka; Meteorological Applications; 19(2); 130 – 139; DOI:10.1002/met.246
66. AJ Litta, UC Mohanty, S. Kiran Prasad, **M. Mohapatra**, AjitTyagi, SC Sahu; 2012; Simulation of tornado over Orissa (India) on March 31, 2009, using WRF–NMM model; Natural Hazards; 61(3).; 1219-1242; DOI:10.1007/s11069-011-9979-1
67. Krishna K. Osuri, U. C. Mohanty, A. Routray, **M. Mohapatra**; 2012; The impact of satellite-derived wind data assimilation on track, intensity and structure of tropical cyclones over the North Indian Ocean; International Journal of Remote Sensing; 33(5-5); 1627-1652; DOI:10.1080/01431161.2011.596849
68. **M. Mohapatra;** 2012; Evaluation of Cone of Uncertainty in Tropical Cyclone Track Forecast over North Indian Ocean Issued by India Meteorological Department; Tropical Cyclone Research and Review, 01, 331-339

69. **M. Mohapatra**, B. K. Bandyopadhyay, AjitTyagi; 2012; Best track parameters of tropical cyclones over the North Indian Ocean: A review; Natural Hazards; 63(3); 1285-1317
70. Suresh Ram and **M. Mohapatra**, 2012, Some aspects of squall over Indira Gandhi International Airport, Mausam, 63, 4, 623-638
71. N. Kumar, **M Mohapatra** and B.P. Yadav, 2011, Boundary layer impact on mountain waves across Western Ghats of India, Mapana, J. Science, 10, 1, 25-31
72. Charan Singh, **M. Mohapatra**, B.K. Bandyopadhyay, AjitTyagi; 2011; Thunderstorm climatology over northeast and adjoining east India; Mausam; 62(2); 163-170.
73. **M. Mohapatra**, R.H. Biswas, G.K. Sawaisarje; 2011; Spatial variability of daily rainfall over northeast India during summer monsoon season; Mausam; 62(2); 215-228.
74. **M. Mohapatra**; 2011; Weather and weather system at Schirmachar Oasis (Maitri): - A review during past two decades; Mausam; 62; 513-534.
75. **M. Mohapatra**; 2011; Modulation of cyclonic disturbances over the north Indian Ocean by Madden - Julian oscillation; Mausam; 62; 375-390.
76. U. C. Mohanty, Krishna K. Osuri, A. Routray, **M. Mohapatra**, Sujata Pattanayak; 2010; Simulation of Bay of Bengal Tropical Cyclones with WRF Model: Impact of Initial and Boundary Conditions; Marine Geodesy; 33(4); 294-314; DOI:10.1080/01490419.2010.518061
77. **M. Mohapatra**, Naresh Kumar, B K Bandyopadhyay; 2010; Role of mesoscale low and urbanization on exceptionally heavy rainfall event of 26th July 2005 over Mumbai: Some observational evidences. Mausam; 60(3); 317-324
78. Ramesh Chand, **M. Mohapatra;** 2010; Diagnostic study of a recurving cyclone - 'MALA' over the Bay of Bengal. Mausam; 61(1); 11-18.
79. **M. Mohapatra** and S. Adhikary; 2010; Seasonal prediction of cyclonic disturbances over the Bay of Bengal during summer monsoon season: identification of potential predictors; Mausam; 61; 461-486.
80. **M. Mohapatra**, Naresh Kumar, B K Bandyopadhyay; 2010; Unprecedented Rainfall over Bangalore City during October, 2005; Mausam; 61(1); 105-112.
81. **M. Mohapatra**, H.R. Hatwar, B.K. Bandyopadhyay, V. Subrahmanyam; 2009; Evaluation of heavy rainfall warning over India during summer monsoon season; Mausam; 60(4); 475-490.
82. **M. Mohapatra**, H.R. Hatwar, S.R. Kalsi; 2009; Verification of heavy rainfall warning over Bihar and Uttar Pradesh; Mausam; 60(2); 175-184.
83. **M. Mohapatra**, U.C. Mohanty; 2009; Excess and deficient summer monsoon rainfall over Orissa in relation to low pressure systems; Mausam; 60(1); 25-38.
84. Sunit Das, **M. Mohapatra** and Suresh Ram; 2009; Some characteristics of heavy rainfall over northeast India during monsoon season; Mausam; 60; 525-533
85. **M. Mohapatra;** 2008;Sub-divisional monsoon rainfall over Orissa in relation to low pressure systems over Bay of Bengal and adjoining land regions during 1982-1999; Mausam; 59(3); 327-338.
86. **M. Mohapatra**, U. C. Mohanty; 2008; Periodicity in intraseasonal variation off summer monsoon rainfall over Orissa, India in relation to synoptic disturbances; Meteor Atmos Phys. Meteorology and Atmospheric Physics; 99(1); 25-42; DOI:10.1007/s00703-007-0268-1
87. **M. Mohapatra**, H. R. Biswas and G. K. Sawaisarje; 2008; Daily summer monsoon rainfall over northeast India due to synoptic scale system; Mausam; 59; 35-50.
88. Suresh Ram and **M. Mohapatra;** 2008**;** Some characteristics of fog over Guwahati airport; Mausam; 59; 159-166.
89. **M. Mohapatra**, U. C. Mohanty; 2007; Inter-annual variability of summer monsoon rainfall over Orissa (India) in relation to cyclonic disturbances; Natural Hazards; 42(2); 301-315; DOI:10.1007/s11069-006-9090-1
90. U. C. Mohanty, **M. Mohapatra;** 2007;Prediction of occurrence and quantity of daily summer monsoon precipitation over Orissa (India); Meteorological Applications; 14(1); 95 – 103; DOI:10.1002/met.9
91. **M. Mohapatra;** 2007; Relative contribution of synoptic systems to monsoon rainfall over Orissa; Mausam; 57(1); 17-32
92. **M. Mohapatra** and U.C. Mohanty; 2007; An objective approach for prediction of daily summer monsoon rainfall over Orissa (India) due to interaction of mesoscale and large scale synoptic systems; Pure and Applied Geophysics**;** 164; 1683-1698

93. **M. Mohapatra**, U. C. Mohanty; 2006; Interannual variability of summer monsoon rainfall over Orissa in relation to tropospheric circulation features; Current Science; 90(9); 1218-1229.
94. **M. Mohapatra**, U C Mohanty; 2006; Spatio-temporal variability of summer monsoon rainfall over Orissa in relation to low pressure system; Journal of Earth System Science; 115(2); 203-218;
95. G. Kumar and **M. Mohapatra;** 2006; Some climatological aspects of thunderstorms and squalls over Guwahati airport; Mausam; 57; 231-240.
96. **M. Mohapatra**, U. C. Mohanty; 2005; Some characteristics of very heavy rainfall over Orissa during summer monsoon season; Journal of Earth System Science;114(1); 17-36. DOI:10.1007/BF02702006
97. **M. Mohapatra**; 2005; Some characteristics of inter-relationship in monthly and seasonal monsoon rainfall over Orissa; Mausam; 693-697
98. **M. Mohapatra**, U. C. Mohanty; 2004; Some characteristics of low pressure systems and summer monsoon rainfall over Orissa; Current Science; 87(9); 1245-1255.
99. **M. Mohapatra**, A. L. Kopar and A. Thulasidas; 2004; Some climatological aspects of thunderstorm activity over Bangalore city; Mausam; 184-189
100. S. Mishra and **M. Mohapatra**; 2004; Some climatological characteristics of fog over Bhubaneswar; Mausam; 55; 695-698
101. **M. Mohapatra;** 2004;Some characteristics of spatial variability of monsoon rainfall over Orissa; Mausam; 55; 351-355
102. **M. Mohapatra**, U. C. Mohanty, S. Behera; 2003; Spatial variability of daily rainfall over Orissa (India) during southwest summer monsoon season; International Journal of Climatology; 23(15); 1867–1887;
103. **M. Mohapatra** and U.C. Mohanty; 2003; Some features of 24 hours highest rainfall over Orissa during monsoon season; Journal of Power and River Valley development**,** 198-206
104. **M. Mohapatra**; 2002; Recent trends in climate of Bangalore; Mausam; 53; 425-438.
105. **M. Mohapatra**, D. C. Gupta, N. K. Chanchalani and S. K. Dastidar; 2002; Orissa Super Cyclone,1999- a case study; Journal of Indian Geophysical Union; 6; 93-106
106. **M. Mohapatra** and A. Thulasidas; 1998; Analysis and forecasting of fog over Bangalore Airport; Mausam; 49; 135-142

Enclosure I: Publications and Research & Development

(b) : Research papers published in Proceedings of Symposia/Seminars/Conference/Workshop

1. Julian Heming, Fernando Prates, Morris Bender, John Cangialosi, Phillippe Caroff, James Doyle, AnumehaDube, Ghislain Faure, Brian Howell, Yohko Igarashi, Ron McTaggart-Cowan, **Mrutyunjay Mohapatra**, Jon Moskaitis, Jim Murtha, Rabi Rivett, Monica Sharma, Chris Short, Amit Singh, Vijay Tallapragada, Helen Titley, Yi Xiao, 2018, Review of Recent Progress in Tropical Cyclone Track Forecasting and Expression of Uncertainties, Reports of WMO/TCP/WWW Ninth International Workshop On Tropical Cyclones (IWTC-9) held at Honolulu, USA
2. **M Mohapatra**, B. K. Bandyopadhyay and L. S. Rathore; 2014; Very Severe Cyclonic Storm (VSCS), "Phailin" over the Bay of Bengal during 08-14 October 2013 : A Demonstration of Early Warning Capability of India Meteorological Department; Proceedings of Third International Workshop on Tropical Cyclone Landfall Processes, WMO/CAS/WWW, 1-20.
3. Woo Wang-Chun,Wallace Hogsett, **M. Mohapatra**, Kazuhiko Nagata, Peter Otto, Qi Liangbo,Vo Van Hoa, Xu Yinglong; 2014; Challenges and Advances related to TC Rainfall Forecast; Third International Workshop on Tropical Cyclone Landfall Processes,WMO/CAS/WWW-8.2, 8.2.1-8.2.29pp.
4. Sai-tick Chan Jim Davidson, Philippe Caroff, Joe Courtney, David Grant, Koji Kato, **M. Mohapatra** and C.H. Qian; 2014; Track, Intensity, and Structure Changes at Landfall – Forecasting Challenges; Third International Workshop on Tropical Cyclone Landfall Processes, WMO/CAS/WWW-6.2, 6.2.1-6.2.23pp.
5. Betty Hearn Morrow,Jeff Lazo, Gary Foley, **M. Mohapatra**, Ray Tanabe, C. C. Lam, Thelma Acebes-Cinko, Chris Landsea, Dong-Jin Kim, Baek-Jo Kim, José M. Robiera Torres, Alvaro Palache, Angel Meulenert, Zhengquan Cheng; 2014; Effective Warning Process: Recent Social Science Contributions; Eighth International Workshop on Tropical Cyclone(IWTC), Topic 3.2, 1-16pp.
6. Charles Sampson and John Knaff,Joe Courtney, Brian Strahl, Tsukasa Fujita, Naohisi Koide, Olivier Bousquet, Thierry Dupont, Mike Brennan, Vijay Tallapragada, Tim Marchok, S.G. Gopalakrishna, Baode Chen, **M. Mohapatra**, S. D. Kotal and U. C. Mohanty, Mike Fiorino, Jim Doyle, Russ Elsberry; 2014; Advances In Intensity Guidance; Eighth International Workshop on Tropical Cyclone(IWTC), Topic 2.7, 1-26pp.

7. Christopher W. Landsea,Lixion Avila, Thierry Dupont, S. D. Kotal and **M. Mohapatra;** 2014;Cyclogenesis: Operational Forecasting Perspective; Eighth International Workshop on Tropical Cyclone(IWTC), Topic 2.2, 1-22pp.
8. Grant Elliott, Munehiko Yamaguchi, Thomas Birchard, Johnny C. L. Chan, Thierry Dupont, Russell L. Elsberry, T C Lee, Xiaotu Lei, Sharanya J. Majumdar, **M Mohapatra** and Li Ying; 2014; Tropical Cyclone Motion - Recent Advances; Eighth International Workshop on Tropical Cyclone(IWTC), Topic 2, 1-44pp.
9. Monica Sharma and **M. Mohapatra;** 2013; Possible causes of explosive intensification of VSCS GIRI over the Bay of Bengal; Proceedings of International Conference on Indian Ocean Tropical Cyclone and Climate Change (14 - 17 February 2012) New Delhi, India, published by WMO, WWRP 2013-4, 131-138
10. T. N. Jha, **M. Mohapatra** and B. K. Bandyopadhyay; 2013; A study of intensification and movement of cyclonic storm " Keila" over Arabian sea; Proceedings of International Conference on Indian Ocean Tropical Cyclone and Climate Change (14 - 17 February 2012) New Delhi, India, published by WMO, WWRP 2013-4, 121-125
11. Naresh Kumar and **M. Mohapatra;** 2013;Physical features associated with rare track and intensity of severe cyclonic storm, AILA over the bay of Bengal during May 2009; Proceedings of International Conference on Indian Ocean Tropical Cyclone and Climate Change (14 - 17 February 2012) New Delhi, India, published by WMO, WWRP 2013-4, 115-120
12. R.P. Sharma, **M. Mohapatra** and B.K. Bandyopadhyay; 2013; Performance of modified CLIPER model for tropical cyclone track prediction over the north Indian Ocean during geostationary satellite era; Proceedings of International Conference on Indian Ocean Tropical Cyclone and Climate Change (14 - 17 February 2012) New Delhi, India, published by WMO, WWRP 2013-4, 29-32
13. D. P. Nayak, **M. Mohapatra** and B.K. Bandyopadhyay; 2013; Variation of tropical cyclone track forecast difficulty over North Indian Ocean; Proceedings of International Conference on Indian Ocean Tropical Cyclone and Climate Change (14 - 17 February 2012) New Delhi, India, published by WMO, WWRP 2013-4, 23-28
14. AjitTyagi, **M Mohapatra**, B. K.Bandyopadhyay and Naresh Kumar; 2010; Interannual variation of frequency of cyclonic disturbances landfalling over WMO/ESCAP Panel Member Countries; WMO Technical Document, WMO/TD-No.1541, WWRP-210-2, 1-7
15. **M. Mohapatra** and B.K. Bandyopadhyay; 2008; Spatio-temporal variability of heavy rainfall over India during monsoon season; SAARC Workshop held in Kathmandu during 27-28 March 2008
16. U. C. Mohanty and **M. Mohapatra;** 2007;Heat waves over Orissa : Problems and perspectives; Understanding heat waves in Orissa, Proceedings of national workshop on heat wave held on 13. 03. 2006 organised by Orissa State Disaster management Authority, Bhubaneswar
17. **M. Mohapatra**, 2003; Southwest monsoon circulation and rainfall over Orissa- A review of characteristics; 7th Orissa Vigyan Congress, Bhubaneswar
18. **M. Mohapatra**; 2003; Climate change and environmental hazards; Seminar on Mitigation of Environmental Hazard- Utkal University
19. S. Mishra, **M. Mohapatra** and U.C. Mohanty; 2002; Some characteristics of monsoon activity over Orissa; National symposium, TROPMET, 2002, organised by Indian Meteorological Society
20. **M.Mohapatra**, U.C. Mohanty, S. Mishra and L. Maharana; 2002; Characteristics of monsoon circulation leading to flood and drought over Orissa; National symposium, TROPMET, 2002, organised by Indian Meteorological Society
21. **M. Mohapatra**; 2002; Tropical cyclone and environmental risk; National Seminar on environmental risk analysis and management, Utkal University
22. **M. Mohapatra**, S.K. Dastidar and D.C. Gupta; 2001; Some aspects of recent heat wave over Orissa; National symposium, TROPMET, 2001, organised by Indian Meteorological Society
23. **M. .Mohapatra** and D.C. Gupta; 2000; Meteorology of Eastern Ghat region of Orissa; National Symposium, RRL Bhubaneswar
24. **M. Mohapatra**, 2000; Weather related disasters and their management; National Seminar on Environment and Disaster Management organised by Utkal University
25. **M. .Mohapatra** and D.C. Gupta; 2000; The impact of monsoon depressions on paddy cultivation over Orissa; National symposium, TROPMET, 2000 organised by Indian Meteorological Society
26. **M. Mohapatra** and G.S. Vijayraghavan; 1997; Climatic variation of temperature over Bangalore; IGBP National Symposium at Bhubaneswar

Enclosure I: Publications and Research & Development

(c) Publications in books/reports

1. **M. Mohapatra** and M. Sharma, 2019, Recent Advances in Cyclone Warning Services in India, Article for Souvenir published by ClimFish Conference held at CUSAT, Kochi
2. **M. Mohapatra** and M. Sharma, 2019, India's contribution in trans boundary early warning system in south Asia: A review, South Asia Disaster Report, Published by Ill India Disaster Management Institute, Ahmedabad.
3. **M Mohapatra**, AK Srivastava, S Balachandran, B Geetha, 2017, Inter-annual Variation and Trends in Tropical Cyclones and Monsoon Depressions Over the North Indian Ocean, In Observed Climate Variability and Change over the Indian Region, Ed. M. Rajeevan and ShaileshNayak, published by Springer, Germany, 89-106.
4. K Ray, **M Mohapatra**, K Chakravarthy, SS Ray, SK Singh, AK Das, 2017, Hydro-Meteorological Aspects of Tropical Cyclone Phailin in Bay of Bengal in 2013 and the Assessment of Rice Inundation due to Flooding, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 29-43
5. M Sharma, **M Mohapatra**, 2017, Standard Operation Procedure for Tropical Cyclone Vital Parameters over North Indian Ocean, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 367-381
6. LS Rathore, **M Mohapatra**, B Geetha, 2017, Collaborative Mechanism for Tropical Cyclone Monitoring and Prediction over North Indian Ocean, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 3-27.
7. B Sabade, **M Mohapatra**, 2017, Very Severe Cyclonic Storm MADI over Bay of Bengal, 6–13 December 2013: A Diagnostic Study, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 117-130
8. PS Chinchole, **M Mohapatra**, 2017, Some Characteristics of Translational Speed of Cyclonic Disturbances Over North Indian Ocean in Recent Years, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 165-179
9. DP Nayak, **M Mohapatra**, 2017, Rapid Movement of Cyclone Viyaru Just Before Landfall-A Case Study, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 149-163
10. SVJ Kumar, SS Ashthikar, **M Mohapatra**, 2017, Life Period of Cyclonic Disturbances Over the North Indian Ocean During Recent Years, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 181-198
11. **M Mohapatra**, 2017, Tropical Cyclone Track, Structure and Intensity Changes at Landfall, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, Co-published by Capital Publishers, New Delhi and Springer, Germany, 97-116
12. RP Sharma, **M Mohapatra**, 2017 Rapid Weakening of Very Severe Cyclonic Storm 'Lehar'–A Case Study, In Tropical Cyclone Activity over the North Indian Ocean, Ed.M.Mohapatra, B.K. Bandyopadhyay and L.S. Rathore, 2017, Co-published by Capital Publishers, New Delhi and Springer, Germany, 131-147
13. **M Mohapatra**, 2017, Monitoring and Forecasting of Tropical Cyclones over North Indian Ocean, In Advanced Numerical Modeling and Data Assimilation Techniques for Tropical Cyclone Prediction, Ed. UC Mohanty and SG Gopalakrishnan, Co-published by Capital Publishers, New Delhi and Springer, Germany, 409-447 pp.
14. **M. Mohapatra**, M.R. Ranalkar& S. Sunitha Devi, 2015, Validation of automatic weather station (AWS) data for monitoring and prediction of the low pressure systems during the monsoon season, IMD Met. Monograph: ESSO Document No.: ESSO/IMD/SYNOPTIC MET/01(2015)/17, pp171-188., IMD, Pune
15. **M. Mohapatra**, B.K. Bandyopadhyay, B. Geetha, Bharati S. Sabade, D.P. Nayak, Monica Sharma, R.P. Sharma, P.S. Chinchole, R.G. Bali, S.V.J. Kumar & V. Vijayakumar, 2015, "Cyclonic activities over north Indian ocean during 2014" and "Performance of track and intensity predication of cyclones by IMD during 2014", IMD New Delhi, Report No. ESSO/IMD/CWD-1(2015)/13, IMD, New Delhi
16. **M. Mohapatra**, B.K. Bandyopadhyay, B. Geetha, Bharati S. Sabade, D.P. Nayak, Monica Sharma, R.P. Sharma, P.S. Chinchole, R.G. Bali, S. V. J. Kumar & V. Vijayakumar, 2015, Verification of operational tropical cyclone forecast over north Indian Ocean during 2014 by India Meteorological Department, IMD Met. Monograph: Synoptic Meteorology No.: ESSO/IMD/SYNOPTIC MET/02-2014/16], pp 46-79., IMD, New Delhi
17. **M. Mohapatra**, B.K. Bandyopadhyay, Kamaljit Ray and L. S. Rathore, 2014, Early Warning Services for Management of Cyclones over North Indian Ocean : Current status and future scope, High Impact Weather Events over SAARC Region, Ed. Kamaljit Ray, M Mohapatra, BK Bandyopadhyay and LS Rathore, Capital Publishing Co. and Springer Publications Ltd

18. **M. Mohapatra** and Manish Ranalkar, 2014, Utility of automatic weather station (AWS) data for monitoring and prediction of cyclonic disturbances during monsoon season, 2013, IMD Met. Monograph, Synoptic Meteorology No. 1/2014, pp. 161-172, IMD, Pune
19. **M. Mohapatra**, Naresh Kumar and Manish Ranalkar, 2012, Utility of automatic weather station (AWS) data for monitoring and prediction of cyclonic disturbances during monsoon season, 2011, IMD Met. Monograph, Synoptic Meteorology No. 1/2011, pp. 161-172, IMD, Pune
20. Manorama Mohanty, **M. Mohapatra** and S.N.A. Jaafry, 2013, Characteristic features of heavy rainfall over Gujarat and Rajasthan states of India due to very severe cyclonic storm, PHET over the Arabian Sea (31 May to 07 June 2010), Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change, Edited by: U.C.Mohanty, M.Mohapatra, O.P.Singh, B.K.Bandyopadhyay, L.S.Rathore, pp-412-421, Capital Publishing Co. and Springer Publications Ltd
21. S. K. Dube, A.D.Rao, JismyPoulose, **M. Mohapatra** and T.S.Murty, 2013, Storm surge inundation in South Asia under climate change scenarios, Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change, Edited by: U.C.Mohanty, M.Mohapatra, O.P.Singh, B.K.Bandyopadhyay, L.S.Rathore, pp-355-363, Capital Publishing Co. and Springer Publications Ltd
22. D. R. Pattanaik and **M. Mohapatra**, 2013, Multi-model Ensemble Based Extended Range Forecast of Tropical Cyclogenesis over the North Indian Ocean, Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change, Edited by: U.C.Mohanty, M.Mohapatra, O.P.Singh, B.K.Bandyopadhyay, L.S.Rathore, pp-203-218, Capital Publishing Co. and Springer Publications Ltd
23. Suman Goyal and **M. Mohapatra**, 2013, Estimation of Centre and Intensity of Tropical Cyclones over the North Indian Ocean using Microwave Imageries, Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change, Edited by: U.C.Mohanty, M.Mohapatra, O.P.Singh, B.K.Bandyopadhyay, L.S.Rathore, pp-192-202, Capital Publishing Co. and Springer Publications Ltd
24. **M. Mohapatra**, B. K. Bandyopadhyay and AjitTyagi, 2013, Status and Plans for operational Tropical Cyclone Forecasting and Warning Systems in the North Indian Ocean region, Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change, Edited by: U.C.Mohanty, M.Mohapatra, O.P.Singh, B.K.Bandyopadhyay, L.S.Rathore, pp-149-168, Capital Publishing Co. and Springer Publications Ltd
25. **M. Mohapatra**, B. K. Bandyopadhyay and AjitTyagi, 2013, Construction and Quality of best tracks parameters for study of climate change impact on Tropical Cyclones over the North Indian Ocean during satellite era, Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change, Edited by: U.C.Mohanty, M.Mohapatra, O.P.Singh, B.K.Bandyopadhyay, L.S.Rathore, pp-3-17, Capital Publishing Co. and Springer Publications Ltd
26. D. R.Pattanaik and **M. Mohapatra**, 2012, Extended range prediction of cyclonic disturbances over the north Indian Ocean, Met Monograph, IMD, New Delhi
27. **M. Mohapatra**, Naresh Kumar and Manish Ranalkar, 2012, Utility of automatic weather station (AWS) data for monitoring and prediction of cyclonic disturbances during monsoon season, 2011, IMD Met. Monograph, Synoptic Meteorology No. 1/2011, pp. 161-172., IMD, Pune
28. **M. Mohapatra**, TN Jha, Suman Goyal, Charan Singh, Naresh Kumar, SD Kotal, K Nagaratna, S Balachandran, Osuri Krishna, AjitTyagi, BK Bandyopadhyay, OP Singh, UC Mohanty, DR Sikka, Kusuma G Rao and EN Rajagopal., 2011, Forecast Demonstration Project (FDP) for improving track, intensity and landfall of Bay of Bengal tropical cyclones, Implementation of Pilot Phase, 2010 : A report, Research Report, Cyclone Warning Division, IMD, New Delhi
29. A.J. Litta, U.C. Mohanty, S.C. Bhan, and **M. Mohapatra**, 2011, Simulation of Tornadoes over India Using WRF-NMM Model, Challenges and Opportunities in Agrometeorology, Eds. S. D. Attri, L. S. Rathore, M. V. K. Sivakumar, S. K. Dash, Springer Publications, pp. 173-186, Springer Publications Ltd
30. Ajit Tyagi, B. K. Bandyopadhyay, **M. Mohapatra**, Suman Goel, Naresh Kumar, A. B. Mazumdar&MedhaKhole, 2011, A report on the super cyclonic storm, "Gonu" during 1-7 June 2007, IMD Met. Monograph, Cyclone Warning Division No. 08/2011, p.1-87, IMD, New Delhi
31. **M. Mohapatra**, Naresh Kumar and Manish Ranalkar, 2011, Utility of automatic weather station (AWS) data for monitoring and prediction of cyclonic disturbances during 2010, IMD Met. Monograph, Synoptic Meteorology No. 10/2011, pp. 189-203, IMD, Pune
32. AjitTyagi, **M. Mohapatra**, B. K.Bandyopadhyay and Naresh Kumar, 2010, Inter-annual variation of frequency of cyclonic disturbances landfalling over WMO/ESCAP Panel Member Countries, WMO Technical Document, WMO/TD-No. 1541 WWRP-210-2, pp. 1-7, WMO, Geneva
33. AjitTyagi, **M. Mohapatra**, B. K.Bandyopadhyay and Naresh Kumar, 2009, Characteristics of very severe cyclonic storm "NARGIS" over the Bay of Bengal during 27th April to 3rd May, 2008, In Indian Ocean tropical cyclones and climate change, Ed. YassineCharabi, 315-326, Springer Publications Ltd
34. AjitTyagi, B. K. Bandyopadhyay, **M. Mohapatra**, Charan Singh, 2009, Characteristics of very severe cyclonic storm "SIDR" over the Bay of Bengal, In Indian Ocean tropical cyclones and climate change, Ed. YassineCharabi, 327-338, Springer Publications Ltd

35. AjitTyagi; B.K. Bandyopadhyay, **M. Mohapatra**, Charan Singh, and Naresh Kumar, 2009, The First Ever Super Cyclonic Storm "Gonu" Over the Arabian Sea during 01-07 June, 2007 – A Case Study, In Indian Ocean tropical cyclones and climate change, Ed. YassineCharabi, 305-314, Springer Publications Ltd
36. **M. Mohapatra**, Tyagi, Ajit and B.K. Bandyopadhyay, 2009, Monitoring and Prediction of Cyclonic Disturbances over North Indian Ocean by Regional Specialized Meteorological Centre, New Delhi (India): Problems and Prospective, InIndian Ocean tropical cyclones and climate change, Ed. YassineCharabi, 93-103, Springer Publications Ltd
37. U.C. Mohanty etal including **M. Mohapatra**, 2009, Weather summary, analysis and preliminary evaluation of meso scale model during pilot experiment of severe thunderstorms : observations and regional modeling (STORM) programme – 2007, Research report, MoES and DST, Govt. of India, New Delhi
38. A.B. Mazumdar, MedhaKhole, **M. Mohapatra** and S. Sunitha Devi, 2009, Semi Permanent Systems and Synoptic Features, Meteorological Monograph on 'Southwest Monsoon – 2008', 7/2009, IMD, Pune
39. **M. Mohapatra**, A. K. Sharma and Suman Goyal, 2009, Utility of Automatic Weather Station (AWS) data for monitoring and prediction of monsoon circulations, Meteorological Monograph on 'Southwest Monsoon – 2008', 7/2009, IMD, Pune
40. R. C. Bhatia, **M. Mohapatra**, S. K. Roy Bhowmik and S. Das, 2008, Utility of automatic weather station data and water vapour derived wind vector in monitoring and prediction of monsoon disturbances, Meteorological Monograph on 'Southwest Monsoon – 2007', 2/2008, IMD, Pune
41. H. R. Hatwar, V. Subrahmanyam, **M. Mohapatra**, B. K. Bandyopadhyaya, S. K. Roy Bhowmik and Kuldip Singh, 2008, Cyclonic storm, 'OGNI' – A case study, Meteorological Monograph Cyclone Warning, 2/2008, IMD, Pune
42. U.C. Mohanty etal including **M. Mohapatra**, 2007, Weather summary, analysis and preliminary evaluation of meso scale model during pilot experiment of severe thunderstorms: observations and regional modeling (STORM) programme – 2007, Research report, DST, Govt. of India, New Delhi

Enclosure I: Publications and Research & Development

(d): Details of Books Edited

1. Annual Cyclone Review- 2007 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2008, WMO, Geneva
2. Annual Cyclone Review-2008 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2009, WMO, Geneva
3. Annual Cyclone Review-2009 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2010, WMO, Geneva
4. Annual Cyclone Review-2010 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2011, WMO, Geneva
5. Annual Cyclone Review-2011 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2012, WMO, Geneva
6. Annual Cyclone Review-2012 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2013, WMO, Geneva
7. Monitoring and prediction of Indian Ocean tropical cyclones and climate change Ed. U.C. Mohanty, **M. Mohapatra**, O.P. Singh, B.K. Bandyopadhyay and L.S. Rathore, 2013, Co- published by Capital Publishers, New Delhi and Springer, Germany
8. High impact weather events over SAARC region, Ed. K. Ray, **M. Mohapatra**, B.K. Bandyopadhyay & L.S. Rathore, 2014, Co-published by Capital Publishers, New Delhi & Springer
9. Annual Cyclone Review-2013 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2014, WMO, Geneva
10. Cyclonic disturbances over north Indian Ocean during 2013, IMD New Delhi
11. Annual Cyclone Review-2013 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2014, WMO, Geneva
12. Cyclonic disturbances over north Indian Ocean during 2014, IMD New Delhi
13. Annual Cyclone Review-2014 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2015, WMO, Geneva
14. Annual Cyclone Review-2015 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2016, WMO, Geneva
15. Annual Cyclone Review-2015 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2017, WMO, Geneva
16. Annual Cyclone Review-2015 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2018, WMO, Geneva
17. Tropical Cyclone Activity over North Indian Ocean, Ed. **M.Mohapatra,** B.K. Bandyopadhyay and L.S. Rathore,

2017, Co-published by Capital Publishers, New Delhi & Springer, Germany, 365 pp.

18. Monsoon 2016- A report, Ed PCS Rao, DS Pai and **M Mohapatra**, 2017, Published by India Meteorological Department, Pune, 374pp.
19. Annual Cyclone Review-2016 for WMO/ESCAP Panel countries, Ed. **M. Mohapatra** and other representatives from WMO/ESCAP Panel countries, 2017, WMO, Geneva
20. Monsoon-2017- A report, Ed O.P. Sreejith, DS Pai and **M Mohapatra**, 2018, Published by India Meteorological Department, Pune

Enclosure I: Publications and Research & Development

(e) Details of Journals edited

1. Editor, **Mausam** published by IMD since August 2019
2. Associate Editor, **Journal of Climate Change**, 2015 onwards, Capital Publishing Co, New Delhi
3. Editor, Special Issue of Journal, **Mausam** (**Volume, 64, No. 1**) on Proceedings of National Conference on Bay of Bengal Tropical Cyclone Experiment (BOBTEX)-2011, Ed. D.R. Sikka, M. Mohapatra and BK Bandyopadhyay, 2013, IMD, New Delhi
4. Editor, Special Issue of Magazine, „**Geography and You**" on cyclone, **2014,** Published by Iris Publication, New Delhi, India
5. Member of Editorial Board, **Tropical Cyclone Research and Review**
6. Member of Editorial Board, **Vayu Mandal**
7. Member of Editorial Board, **Arabian Journal of Geo Sciences**
8. Guest Editor, Special Issue of **Journal of Natural Hazards, 2020**

Enclosure I: Publications and Research & Development

(f) Reviewer of journals/books

Worked as a Reviewer for publication of research papers in following Journal/ publications

International Journals:

(1) International Journal of Natural Hazards
(2) International Journal, 'Marine Geodesy'
(3) Advances in Space Research
(4) Geomatics, Natural Hazards and Risk
(5) Tropical Cyclone Research and Review
(6) Theoretical and Applied Climatology
(7) Weather and Climate Extremes
(8) Climate Dynamics
(9) International Journal of Remote Sensing

National Journals

(10) Journal of Earth System Sciences
(11) Current Science
(12) Journal, 'Mausam',
(13) Vayu Mandal

Books

(14) Book on Indian Ocean Tropical Cyclones and Climate Change, Ed. YassineCharabi, Sultan Qubus University Muscat, Oman in 2009 and published in 2011 by Springers..
(15) Book on Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change published in 2013 by Springer and Capital Publishers.
(16) Book on High impact weather events over SAARC region published in 2014 by Springer and Capital Publishers.
(17) Book on Tropical Cyclone Activity over the North Indian Ocean, published in 2017 by by Capital Publishers and Springer, Germany
(18) Book on Advances in observation, assimilation and forecasting of tropical cyclones published in 2017 by Springer and Capital Publishers

ENCLOSURE II: Specialisation: Weather Forecasting and cyclone warning Services

Specialisation of Dr. M. Mohapatra, IMD in Weather Forecasting and Cyclone Warning Services included (i) project and programme management, (ii) policy and planning at national and international levels, (iii) Modernisation of Weather Forecasting &Warning System and Services through introduction of new technology, new methodology, national and international collaborations, R&D and warning dissemination mechanism. Details of contribution in this specialized field are given below in section (i) to (iii). The outcome of the specialized contribution made by Dr Mohapatra is presented in Section (iv)

(i) Major projects/programmes dealt

- *Modernisation of Indian Meteorological observational systems and applications (MIMOSA)/ VARSAMAN Project as Associate Project Director.*
- Modernisation of Cyclone Warning System as Project Director
- Forecast Demonstration Project (FDP) on landfalling cyclones over the Bay of Bengal as Project Director
- FDP on Severe Thunder Storm Observation and Regional Modeling (STORM) project (2006-18)
- FDP on Winter Weather (2016-19)
- FDP on southwest monsoon (2017-18)

(ii) ***(a)Policy and Planning: National***

- Vision document on cyclone and weather forecasting
- Benchmarking of severe weather forecasting
- Standard Operation Procedure (SOP) for weather forecasting and cyclone warning services
- Introduction of district level impact based forecast and its verification for all severe weather events.
- Chairman/member of expert committee for NDMA Guidelines for (i) cyclone management, (ii) Thunderstorm management, (iii) heat wave management
- Chairman of Technical Evaluation Committee for Consultancy on World Bank aided National Cyclone Risk Mitigation Project (NCRMP), Govt. of India
- Disaster Risk Reduction as member of various committees for policy, planning and guidelines

(a) Policy and Planning: International

- Contributed as Permanent Representative of India with WMO with effect from 10th June, 2019
- Contributed as Member Executive Council, WMO with effect from 13th June, 2019 for the period 2019-23
- Contributed as Chairman of WMO/ESCAP Panel on Tropical Cyclones over Bay of Bengal and Arabian Sea for 2017-2018for development of Coordinated Technical Plan
- Contributed as Chairman for Regional Sub-Project management Team for WMO‟s SWFDP-Bay of Bengal and prepared implementation plan
- Contributed as Rapporteur of WMO/ESCAP Panel on Tropical Cyclones for development and updating of Annual Tropical Cyclone Operational Plan for the region

(iii) ***Modernisation of Weather Forecasting &Warning System and Services:***

(a) Introduction of Scientific and technological methodology:

- Increase in lead period of cyclogenesis forecast to 3 days from 2014 & 5 days from 2018
- Extended range forecast of cyclogenesis for next two weeks issued every Thursday from 2018,
- Track, cone of uncertainty & intensity forecast upto 72 hrs since 2009 and 120 hrs since 2013
- Track and intensity forecast from deep depression stage since 2009 and from depression stage since 2018
- Hourly update on day of landfall since 2013
- Nowcasting of severe weather for all districts round the clock and for 1084 cities and towns
- Bi-weekly outlook for all severe weather events
- Forecast demonstration project for all severe weather events round the year from 2016
- Prognostic & diagnostic features and cyclone since 2009 and other severe weather events since 2016
- Warning graphics since 2009,
- Fishermen warning for entire north Indian Ocean valid upto five days from 2018.
- Colour coded impact based forecast & warning for all districts, capital cities & all severe weather events from 2018 and warning with impact information & suggested actions since 2020 in nowcast and short to medium range forecast scale.
- Introduction of Movie loop on 5 days forecasts & warning in IMD website Door Darshan

- Synergised SOP with INCOIS for sea state, marine weather and cyclone forecasting.
- Verification of forecast from 2008 and for past forecasts upto 2003 for heavy rain and cyclone.
- Verification of forecast from 2008 and for past forecasts upto 2003 for heavy rain and cyclone.
- Introduction of Sub-city forecast in 2020
- Modification of NDMA guidelines for thunderstorm, lightning, heat wave, cold wave & fog in 2019
- Extension of city forecast to 518 stations in 2020
- Extension of nowcast for all severe weather and all districts and 1084 stations by 2021
- Cyclone forecast in GIS in 2020
- Extensive use of social media including press release, press conference, Facebook, Twitter, Instagram, Blog, You Tube, Videos, whats-app group etc since 2019-20
- Augmentation of Sectoral applications

❖ Implementation of IFLOWS for Chennai and Mumbai for urban flood warning
❖ Introduction of probabilistic quantitative precipitation forecast(QPF) for all river basins) upto five days
❖ Introduction of extended range forecast for river basins
❖ Agriculture sector (Connectivity among SMS, MCs/RMCs through VC and Whats app group, dissemination improvement)
❖ Graphics product for fishermen warning covering entire north Indian Ocean, IBF over the Ocean
❖ Augmentation of model guidance, observational network and number of airports under Udaan Scheme
❖ Observational and forecast service for Railways along the Railway line
❖ Observational and Forecast services for Golden Quadrilateral

(b) Introduction of new technology:

- Adaption of new versions of global & regional deterministic & ensemble models
- Implementation of atmosphere Ocean coupled Hurricane weather research forecast model
- Tropical Cyclone Module and Ensemble prediction system (EPS)
- Synthetic vortex of cyclone for NWP model improvement.
- IIT Delhi storm surge model and INCOIS Coastal inundation model
- Digital Forecasting workstation and PWS
- Visualisation tool and decision support system, METCAP PLUS
- Development of forecasting infrastructure for all MCs and RMCs
- Implementation of GIS application in weather forecasting
- Automation of weather monitoring and forecasting products generation and presentation
- Long range forecast of spatial distribution of monsoon rainfall for individual months of the season and season as a whole

(c) Networked programmes initiated/conducted:

- **Between lab to lab**Network programmes initiated and continued with

(i) INCOIS for storm surge modeling, HWRF modeling and warning dissemination
(ii) NIOT for meteorological buoy network planning and data exchange and evaluation
(iii) NCMRWF for implementation of global deterministic and ensemble models,
(iv) ISRO for customized satellite product development, planning and validation of products
(v) IAF, Indian Navy for meteorological observations including lightning data
(vi) IIT Delhi for storm surge modeling, coastal inundation
(vii) IIT, Bhubaneswar for HWRF Modeling

- **Bilateral/Multilateral** network programmes conducted with

(**i).** NOAA USA for adaptation of HWRF model in IMD,
(**ii).** JMA for Ensemble prediction system,
(iii). WMO/ESCAP Panel for regional cyclone operational plan,
(iv). WMO Typhoon Committee for synergized SOP for coastal multi-hazard warning,
(v). WMO's Severe weather forecast demonstration project(SWFDP)-southeast Asia
(vi) WMO's SWFP-South Asia for forecast on heavy rain, wind, wave & storm surge
(**vii)** International best track archives for climate stewardship (IBTrACS), USA
(viii) Typhoon committee and WMO/ESCAP Panel on Tropical Cyclones for synergized standardized Operation procedure (SSOP) for coastal hazards in the region
(ix) NDMA and state Govts for Guidelines and common alert protocol,
(x) Bureau of Indian Standards for Standardisation of smart cities, cyclone shelters etc,

(xi) Ministry of Urban Affairs for preparation of Vulnerability Atlas

(d) R&D activity

- **Forecast demonstration projects (FDP)** on landfalling cyclones during 2008-2019
- **FDP** on winter season severe weather events since 2016-17
- **FDP** on pre-monsoon convective weather systems since 2017
- **FDP** on southwest-monsoon season since 2017
- **Data bases prepared** for R&D activity: **(i)** Six hourly best track parameters of cyclones during 1990-2018, **(ii)**Digitisation of Annual RSMC Reports during 1990-2017, **(iii)** Hazard proneness of coastal districts, (**iv**) Tropical Cyclone Energy Metrix, (**v**) Life Cycle, (**vi**) Structure, (**vii**) Translational Speed and direction of Movement since 1990 onwards
- **Organisation Conference and Workshops and Publication of research papers**

(e) Warning dissemination mechanism:

Introduced **(i)** Press Conference, **(ii)** Press release, **(iii)** Dedicated website/web page for cyclone and other severe weather events, **(iv)** SMS alert to fishermen, farmers, disaster managers with extension of whats app groups upto active farmers, **(v)** Email for warning service(**vi**) Implementation of common Alert protocol for warning dissemination, (**vii**) Implementation of warning dissemination through social media. (viii) Development of new website for general public (www.mausam.imd.gov.in), development of mobile apps (Umang, Damini and Mausam)

(f) Confidence building measures for disaster managers:

- ❖ Organisation of users workshop for severe weather and documentation on each cyclone and its forecast since 2008
- ❖ Pre-cyclone and pre-monsoon excercise with disaster managers
- ❖ Verification of all forecasts

(g) Outreach programmes

- FAQs, Terms and Terminology of weather monitoring and forecasting,
- Popular talks/lectures, Popular articles
- ***Production of video films on***

i. A Glorious Decade of IMD (2006-2016) released on First Decadal Celebration of Ministry of Earth Sciences, Govt. of India

ii. Cyclone Warning in India: A Success Story, released on Foundation Day of India Meteorological Department on 15 January 2017.

iii. Early Warning System of IMD released on Foundation Day of India Meteorological Department on 15 January 2019.

(iv) ***Outcome:***

1. Improvement in forecast accuracy:

There has been significant improvement in forecasting accuracy with respect to severe weather events including tropical cyclones, heavy rainfall, fog, heat wave, cold wave, thunderstorm. In general, there has been 20 to 40 percent improvement in forecast accuracy of severe weather events in recent five years (2016-2020) as compared to previous five years (2011-15). The improvement in forecast accuracy with respect to different severe weather events are given below.

(a) Tropical Cyclones forecast accuracy

(i) Track forecast: The annual average track forecast errors in 2020 have been 72 km, 85 km and 111 km, respectively for 24, 48 and 72hrs against the past five years average error of 80, 125 and 177 km based on data of 2016-2020. The errors have been significantly lower during last year (2020) as compared to long period average (2015-19) for all lead periods upto 120 hours.

Comparing the track forecast errors of 2016-2020 against that of 2011 – 2015**, t**here has been continuous improvement in track forecast accuracy with decrease in track forecast errors and increase in skill. The track forecast error has decreased from 97, 145 and 183 km during 2011-15 to 77, 117 and 159 km during 2016-2020 for forecast issued 24 hours, 48 hours and 72 hours ahead (Fig.1). Similarly, the skills of cyclone track forecast have improved from 49%, 63% & 69% during 2011-15 to 64%, 76% & 78% during 2016 to 2020 for forecast issued 24 hours, 48 hours and 72 hours ahead. The uncertainty in track forecast for all the lead period upto 5 days has been reduced by about 30% during the same period.

(ii) Landfall forecast: The annual average landfall point forecast errors for the year 2020 have been 18 km, 70 km and 43 km for 24, 48 and 72 hrs lead period against the long period average of past five years during 2015-19 of 47 km, 70 km and 110 km. The landfall point forecast error of 56 km ,94 km, 106 km during 2011-15 has

decreased to 32 km, 62 km and 92 km during 2016-20 for forecast issued 24 hours, 48 hours & 72 hours ahead of landfall of cyclone.

(iii) Intensity forecast: The average absolute errors in intensity represented by the maximum sustained wind speed, during 2020 have been 7.1 nautical miles per hour (knots), 8.8 knots and 9.3 knots respectively for 24, 48 and 72 hrs lead period of forecast against the long period average errors of 8.9, 13.0 and 15.4 knots during 2015-19. One nautical mile per hour is equal to 1.86 kmph. As regards improvement in intensity forecast over the past 10 years there has been decrease in errors. The intensity (wind) forecast errors have decreased from about 12, 17, 18 knots during 2011-2015 to 8, 11, 14 knots during 2016 to 2020 for the forecast issued 24, 48 and 72 hours ahead

(b) Heavy rainfall: The probability of detection in case of heavy rainfall at meteorological subdivision levels has increased from 50% during 2014 to 77% during 2020 for 24 hours lead period (day1), from 48% to 70% for 48 hours (day2) lead period and from 37% to 66% (day3) for 72 hours lead period. The heavy rainfall forecast issued in 2020 five days ahead has the accuracy of about 59% against the forecast accuracy of 50% in 2014 only 24 hrs ahead. Thus there is a gain of four days in lead period of forecast of heavy rainfall in 2020 as compared to 2014. The missing rate in case of heavy rainfall has decreased from 50% during 2014 to 23% during 2020 for 24 hours lead period, from 52% to 30% for 48 hours lead period and from 63% to 34% for 72 hours lead period.

(c) Heat wave: The probability of detection in case of heat wave at meteorological subdivision levels has improved from 67% (2014) to 100% (2020) for 24 hr lead period, 50% (2014) to 95% (2020) for 48 hr lead period and 27% (2014) to 90% (2020) for 72 hr lead period. The forecast issued in 2020 five days ahead has the accuracy of about 62% against the forecast accuracy of 68% in 2014 only 24 hrs ahead. Thus there is a gain of four days in lead period of heat wave forecast in 2020 as compared to 2014.

(d) Thunderstorm: The probability of detection of thunder storms three hours in advance issued at station levels has increased from 61% (2014) to 88% (2020). The probability of detection of thunder storms 24 hours in advance at meteorological subdivision levels has increased from 31% (2016) to 80% (2020).

2. Reduction in loss of lives and properties

There has been increase in confidence of disaster managers and public leading to

(a) Minimum loss of human lives (limited to double digits) in recent years due to cyclones and heat waves (Fig. 7 & 8)

(b) Decrease in area of evacuation by 100 km in 5 years and hence evacuation cost in case of a landfalling cyclone.

(c) Decrease in ex-gratia paid by Govt. to survivors

(d) Cyclone forecast accuracy also benefited all the Bay of Bengal and Arabian Sea Rim countries to minimize the loss of lives and properties as IMD provides tropical cyclone advisories to these countries. Similarly, the other severe weather including heavy rain, wind and wave guidance provided by IMD also helps south Asian countries

Enclosure III: Project/Programme Management

Major projects/programmes dealt by Dr. M. Mohapatra are given below.

1. **Project/ programme: Modernisation of Indian Meteorological observational systems and applications (MIMOSA)/ VARSAMAN Project.**

Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme

- Worked as a Associate Project Director (Weather Forecasting) and contributed in the planning of the project including system design with respect to weather forecasting system

(b) Implementation of the Project/ programme

- The project has been completed. The weather forecast work station has been running smoothly in different offices of IMD
- As Associate Project Director (Weather Forecasting), I contributed in the implementation of the project, especially in system design and training with respect to Forecasters' workstation,

(c) Evaluation after completion of the Project/ programme

- Modernisation of weather forecasting has brought out a paradigm shift in weather forecasting through improved forecasting skill, efficient service delivery, introduction of digital public weather service.
- It has improved the image of Ministry of Earth Sciences in general and IMD in particular.

2. Project/programme: Modernisation of Cyclone Warning System

Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme

- As Head of Cyclone Warning Division, I formulated the programme for modernization of cyclone warning system of IMD.
- As per the decision taken by Govt. of India, a World Bank sponsored project called National Cyclone Risk Mitigation Project (NCRMP) was taken up in 2007 with IMD dealing with component A of the project, which deals with Early warning system. However, with the modernization programme, IMD decided to carry out the modernization of cyclone warning system under its own programme.
- Programmes were formulated for various components of Early Warning System of Cyclones including (i) observation, (ii) analysis, (iii) tools and technique, (iv) warning product generation, (v) warning dissemination, (vi) capacity building through training, (vii) triggering mechanism, (viii) confidence building measures for users including disaster managers.

(b) Implementation of the Project/ programme

- The project has been completed. The tropical cyclone module is operational at IMD cyclone forecasting workstation. The objective was carried out with preparation of vision document, benchmarking and development of standard operation procedure, acquisition of tools and techniques, augmentation of observational network, collaboration with national and international agencies, training programmes, conduct of national and international workshop/conference, users workshop, verification of forecast, documentation and publication.

(c) Evaluation after completion of the Project/ Programme

- Modernisation of cyclone warning system has brought out a paradigm shift in cyclone warning activity in the country through improved forecasting skill, efficient service delivery (timeliness, frequency, products, dissemination technique) by introduction of digital public weather service. The loss of lives has been minimized with accurate forecasting, warning and advisory support to disaster managers and general public. Cyclone, Titli, Luban, Sagar, Mekunu in 2018, Vardah in 2016, Hudhud in 2014 and Phailin in 2013 are good examples to demonstrate the above.
- The cyclone warning service of IMD has earned many laurels to IMD and Ministry of Earth Sciences from various national and international agencies. For the first time, IMD has got a National Award from Indian

Institute of Management for accurate forecast, early warning and dissemination in case of cyclone, Phailin.

3. **Project/Programme: Forecast Demonstration Project (FDP) on landfalling cyclones over the Bay of Bengal**

Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme

- Worked as an Associate Project Director (Operation) and contributed in the planning of the project including science plan, operation and execution plan. Subsequently acted as Project Director.

(b) Implementation of the Project/ programme

- As Associate Project Director (Operation)/ Project Director, implemented the the project during 15 Oct- 30 Nov 2008-18. My significant contributions include the following.
- Conduct of meeting of National Operation Committee.
- Preparation of daily weather summary and advisory report.
- Conduct of Intense observation period (10P)
- Preparation of report on the implementation.

(c) Evaluation after completion of the Project/programme

- All annual reports on the implementation 2008-17 has been published.
- The performance of models and operational forecast issued during cyclones has been evaluated and the same is incorporated in the above report.
- The lessons learnt from the regular yearly exercise have also been presented, which will help in carrying out subsequent improvement in cyclone warning.

4. **Project/ programme: FDP on Severe Thunder Storm Observation and Regional Modeling (STORM) project (2006-21)**

Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme : Contributed in preparation of Implementation plan

(b) Implementation of the Project/ programme

- Coordinated and participated in the meeting during the project periodfor preparation of daily report.
- Contributed in the preparation of the climatology of thunderstorms over the region and development of post processed products of various models.

(c) Evaluation after completion of the Project/ programme

Contributed in publication of the Annual Implementation Report of the Project as co-author.

5. **Project/ programme: FDP on Winter Weather (2016-21)**

Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme : Preparation of implementation plan

(b) Implementation of the Project/ programme

- Coordinated and Participated in meeting during project period for preparation of daily report
- Development of post processed products of various models.

(c) Evaluation after completion of the Project/ programme

Contributed in publication of the Annual Implementation Report of the Project.

6. **Project/ programme: FDP on southwest monsoon (2017-21)**

Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme : Development of implementation plan

(b) Implementation of the Project/ programme

- Coordinated and participated in meeting during project period for preparation of daily report
- Development of post processed products of various models.

(c) Evaluation after completion of the Project/ programme

Contributed in publication of the Annual Implementation Report of the Project as co-author.

7. WMO Severe Weather Forecast Demonstration Project (SWFDP)- Bay of Bengal

The severe weather forecasting demonstration project (SWFDP)-Bay of Bengal (BOB) was initiated with effect from September 2015. RSMC New Delhi has been identified as the specialised meteorological centre for issuing SWFDP warnings to countries such as Bangladesh, Myanmar, Thailand, Sri Lanka and Maldives in BOB region. It has been extended to Bhutan, Nepal and Pakistan since 2018. The project includes warnings for tropical cyclones, heavy rainfall, strong winds and sea waves. A separate web page has been developed for SWFDP(BOB) in the RSMC New Delhi web site and warning products were uploaded during the SWFDP training programme conducted at Bangkok during September 2015 and Colombo during 2018. RSMC New Delhi provided resource persons for this training programme. Scientific contributions in different stages of the Project/ programme are as follows.

(a) Formulation of the Project/ programme : Initiated the project proposal to WMO and DGM, IMD

(b) Implementation of the Project/ programme

- Acted as the Chairman of Regional Sub-project management Team (RSMT) and also Focal Point for India for the project
- Helped in conducting the training programme at Macau, in 2013, Bangkok in 2015, Colombo in 2018.Delivered lecture in the training programme at Macau and Colombo.
- Developed the website for the project.
- Introduced Pilot Phase of the Project from may 2016 and provided daily regional severe weather forecast guidance valid for next five days
- Chaired RSMT at Colombo in Dec. 2018 for modification of Implementation plan and commencement of Field Phase of the project.

(c) Evaluation after completion of the Project/ programme

Project has been evaluated with commencement of Field Phase from June, 2019. Evaluation plan of the project has been prepared.

Enclosure IV

Summary of Scientific Contributions of Dr Mrutyunjay Mohapatra

Dr M Mohapatra significantly contributed to remarkable improvement in cyclone warning services by India Meteorological Department(IMD) as (i) Project Director for modernisation of weather forecasting and cyclone warning services of IMD, (ii) Project Director for Forecast Demonstration Project of landfalling cyclones, (iii) Head of Cyclone Warning Division and (iv) WMO recognised Regional Specialised Meteorological Centre for cyclones since 2008. His contribution as team leader not only helped India to manage cyclones, but also all Bay of Bengal and Arabian Sea countries.

Dr. Mohapatra led upgradation of cyclone warning services in a holistic manner addressing all components of early warning including (i)policy and planning, (ii)vision and strategy, (iii)observations, (iv)monitoring, (v)analysis, (vi)modelling, (vii)forecasting, (viii)early warning, (ix)capacity building, (x)confidence building measures and (xi)outreach. For improvement in policy and planning he developed Vision 2020 document in 2010(Mohapatra and Rao, Vision-2020, MoES). He followed benchmarking procedure to fix target of improving forecast accuracy of landfall, track, intensity and associated adverse weather like heavy rainfall, wind and storm surge by 20% by 2015 and 40% by 2020.

His work helped in planning of standardization of monitoring and analysis procedure(Mohapatra et al, 2012, Best track parameters of TCs, Natural Hazards). He contributed in introduction of objective technique for cyclone monitoring and forecasting decision support system by IMD in 2009(Mohapatra etal, 2013, Mausam), standard operation procedure(IMD, 2013) which is revised in 2021(IMD, 2021). He was member of committee for development of NDMA guidelines for cyclone management published in 2008(NDMA, 2008) and modified version in 2020, Vulnerability Atlas of India and Bureau of Indian Standards for cyclone resistant shelters.

His work on cyclone hazard proneness districts is used in planning/preparedness including construction of cyclone shelters and other structures in cyclone prone districts and for planning other mitigation measures(Mohapatra et al, 2012, Classification of cyclone hazard prone districts of India, Natural Hazards). He was Chairman of committee for technical evaluation of web based decision support system for National Cyclone Risk Mitigation Project of Govt. of India.

Based on strategy document, nominee played active role for introduction of new technologies in monitoring and forecasting of cyclones such as (i) establishment of digitised forecasting platform replacing conventional system and public weather services system, (ii) cyclone decision support system (iii)adoption of new versions of global and regional deterministic and ensemble prediction systems, storm surge and coastal inundation models (Mohapatra et al, 2013). His contribution in numerical modeling led to customization of high resolution meso-scale model for cyclone and associated adverse weather prediction(a. Osuri, Mohapatra et al; 2013; Journal of Applied Meteorology & Climatology; b. Osuri and Mohapatra et al, 2012, Natural Hazards; c. Mohanty and Mohapatra et al, 2010, Marine Geodesy and d. Osuri, Mohapatra et al, 2010, IJRS).

He introduced scientific methodology in cyclone forecasting including (i)extension of lead period of cyclogenesis forecast from 1 day in 2008 to 3 days in 2014 and 5 days in 2018 (ii)cyclone track and intensity forecast from 24 hrs in 2008 to 72 hrs since 2009 and to 120 hrs since 2013(Mohapatra and Sharma, 2019). He introduced (i)extended range forecast(for next two weeks) for cyclogenesis in 2018, (ii)fishermen warning for entire north Indian Ocean since 2018 in both graphic and textual form which was previously issued along Indian coast only (iii)district-wise impact based forecast and warning in color coded form and (iv)verification of forecast from 2008 for building confidence of disaster managers and public(Mohapatra and Sharma, 2019). Introduction of technology & scientific methods by him for improving track, intensity & structure forecasting(Mohapatra et al, 2013, JESS; Mohapatra et al, 2013, Natural Hazards; Mohapatra et al, 2015, Mohanty, Mohapatra, et al, 2015, Earth Interactions and Mohapatra & Sharma, 2015, JESS, Mohapatra and Kumar, 2017, Climate Dynamics) and associated adverse weather including heavy rain, gale wind, storm surge forecast(Mohapatra, 2015, TCRR, Srinivas Kumar, Mohapatra et al, 2015, Marine Geodesy, Murty, Mohapatra et al, 2017, Ocean Engineering) helped in improving forecast accuracy, increased lead period, impact and action oriented warning. The track forecast accuracy increased by 70 percent and landfall forecast accuracy by 80 percent by 2020 compared to 2010.

He contributed towards building capacity of forecasters by organising more than 25 National & International trainings, 15 National & International workshops, conferences, more than 120 popular lectures and talks. He contributed towards documentation of each cyclone since 2008, development of dedicated website for cyclones & cyclone e-Atlas for R&D and confidence building measures. His expertise in cyclone warning helped in better management of cyclones by disaster managers and public leading to minimum loss of human lives (double digits) in recent years, decrease in area of evacuation by 300 km in 20 years, hence evacuation cost by 60 percent and decrease in ex-gratia paid by Govt. to survivors by about 99 percent compared to 1999 apart from other socio-economic benefit.

Enclosure V: Awards and recognitions received

(a) Fellowship

(i) Conferred Honorary Doctor of Science (D.Sc.) from FM University, Balasore, Odisha-2020 **for his indomitable spirit for serving society and life time contribution to Science & Technology** during it's 10th Convocation Ceremony on 4th March, 2020

(ii) Conferred the degree of **Doctor of Science (Honoris Causa)** by Fakir Mohan University, Balasore, Odisha for his indomitable spirit for serving society and life time contribution to science & technology during it's 10th Convocation Ceremony on 4th March, 2020.

(iii) Conferred Fellowship of Indian Meteorological Society for brilliance & expertise in cyclones prediction that has led to significant reduction in loss of lives due to cyclones in recent years and earned laurels to the country from various international and national agencies .

(ii) Conferred Fellowship of Indian Climate Congress for outstanding contribution in Cyclone monitoring, forecasting and meteorological applications.

(b) Awards

(i) **Chintamani Memorial Medal- 1985** from Rotary Club of India, Bhadrak Branch, Odisha for securing highest mark in physics in B.Sc.

(ii) **Commendation certificate during 1989** from Defence Research and Development Organisation, Ministry of Defence, Govt. of India for significant contribution to Integrated Guided Missile Development Programme

(iii) **Certificate of Merit for Young Scientist Award – 2008** by Ministry of Earth Sciences, Govt. of India for outstanding contribution in the field of atmospheric science and technology

(iv) **25th Biennial Mausam Award (2008-2009)** for the research paper, entitled, 'Daily summer monsoon rainfall over northeast India due to synoptic scale systems' published in the journal, MAUSAM (2008, Vol.59, No. 1)

(i) **Achiever's Award-2013** given by IMD to Cyclone Warning Division on the occasion of Foundation Day, 2014 for excellence in cyclone monitoring, prediction and warning services

(ii) **Commendation Certificates** for cyclone warning services and being elected to the Executive Council of WMO:

- Gantantrik Nagrik Parishad, Bhadrak Odisha
- Zila Biju Smriti Committee, Bhadrak Odisha
- Retired Employees Association, Bhadrak, Odisha

(vi) **Bharat Gaurav Award** by Jai Bharat Foundation, Cuttack, Odisha

(vii) **Felicitation by Sh. Naveen Pattanaik, CM of Odisha** for **outstanding contribution in disaster management** on the occasion of "National Disaster Reduction Day and Odisha State Disaster Preparedness Day" held at Bhubaneswar on 29th October, 2019

(viii) **Felicitation by Utkal University** in recognition to **services to nation** especially in cyclone warning

(ix) **Appreciation by Sh. Farooq Khan, IPS and Advisor to LG Jammu & Kashmir** during Regional conference on "Jal Shakti and Disaster Management" at Jammu **for accurate early warning services especially cyclones**

(x) **Satyasai Samman-2019** by Satyasai Charitable and Education Trust, Odisha **for distinguished contribution in cyclone monitoring, forecasting and meteorological applications**

(xi) **Bhumiputra Samman** by the Bipalbai Behera Chakradhar Smruti Sansad, Ghanteswar, Odisha **for Cyclone Warning Services**

(c)Appreciations

(i) Appreciations received for improvement in cyclone warning services

- **Appreciations received globally and nationally from government and non-government agencies** for successful predicting of cyclones Phailin (2013), Hudhud (2014), Vardah (2016), Sagar, Mekunu, Titli & Luban (2018), FANI (2019) and Amphan

& Nisarga (2020)

- **Publications in leading TV/News Papers** of India highlighting the role of Dr M Mohapatra in improvement of cyclone warning services

(ii) Appreciations for official publications

- **Appreciation from Director General of Meteorology**, India Meteorological Department for significant contribution in publication of manual entitled, Standard Operation Procedure : Weather Forecasting and Warning‟
- **Appreciation from National Institute of Disaster Management** for review of their training module for Training of Trainers (TOT) on Cyclone Disaster Management

(iii) Appreciations received for conducting training and delivering lectures

- **Appreciation from WMO** for delivering lecture in training programme of Severe weather forecast demonstration project (SWFDP) at Macau during 8-13 April 2013
- **Appreciation from WMO** for delivering lecture and organizing the training programme on Dvorak Technique and tropical cyclone forecasting at Muscat, Oman during 28 Sep-02 Oct 2014

(iv) Appreciation for organising meeting/workshop/conference

- **Appreciation from WMO** for organizing 43rd Session of WMO/ESCAP at New Delhi during 2-6 May,

d) Appreciations earned for IMD

(i) Appreciations received for cyclone warning services

- **Appreciation from WMO and Ministry of Earth Sciences** for providing timely and accurate tropical cyclone advisories to Myanmar during cyclone, „Nargis‟: 2008.
- **Appreciations globally and nationally** from government and non-government agencies, scientific community, press and electronic media for successful forecasting and warning services for very severe cyclonic storm, Phailin in Oct., 2013. A few are mentioned below:

(1) ICHL 2013 Award for Excellence in Humanitarian Action

(2) Appreciation from WMO

(3) Appreciation from WMO-Regional Association-II

(4) Appreciation from NDMA

(5) Appreciation received for National Institute of Advance Studies, Bangalore

(6) Appreciation from Hon‟ble P.M. Dr. Manmohan Singh for successful prediction of cyclone "Phailin (2013)"

(7) **Appreciations globally and nationally** from government and non-government agencies, scientific community, press and electronic media for successful forecasting and warning services for very severe cyclonic storm, **Hudhud in Oct., 2014**. A few are mentioned below:

- Appreciation from Prime Minister of India during visit Visakhapatnam on 13 Oct. 2014
- Cyclone Hudhud stood in 9 position in Top Searched New Events in India for 2014 according to Google Search
- Advances in cyclone forecasting and warning is appreciated by Prime Minister102nd Indian Science congress on 3rd January 2015
- Advances in cyclone forecasting and warning were appreciated on the occasion of Prawasi Bhartiya Diwas (7-9 Jan 2015)
- **Appreciation by 104th Indian Science Congress, January 2017** for successful prediction of cyclone **"Vardah (2016)"**
- **Appreciation by Parliamentary Standing Committee on Science & Technology, 2017** for successful prediction of cyclone **"Hudhud (2014) & Vardah (2016)"**
- **Appreciation from WMO** on forecast of cyclones **Sagar and Mekunu, 2018**
- **Appreciation from WMO** for monitoring of **VSCS Titli and Luban, 2018**

- **Appreciation from various agencies/individuals for** launching of dedicated website on cyclone on 3 April 2014
- **Appreciation from United Nation**s for pin point accuracy in monitoring of **ESCS FANI, 2019**
- Appreciation from **WMO** for pin point accuracy and warning services during **Super Cyclonic Storm Amphan in 2020**
- Appreciation from **DG NDRF, Governments of Odisha and West Bengal** for successful prediction of **Super Cyclonic Storm Amphan in 2020**
- **Appreciation globally and internationally for successful prediction of ESCS Tauktae and VSCS YAAS.**

(ii) Appreciation for heavy rainfall warning services

- **Hon'ble Prime Minister Shri Narendra Modi** in his Mann Ki Baat dated the 31st July, 2017 urged people to follow IMD"s forecast to reduce losses after his visit to flood hit areas of Gujarat
- **Appreciation from President's House** for accurate forecast during „**Swearing In Ceremony of Government in May, 2019**"

(iii) Appreciation for Heat wave warning and Heat Action Plan

- IMD received Earth Care Award from Times Group in 2018 for development and implementation of Heat Action plan in the country

(iv) Appreciation for thunderstorm warning services

- NDMA appreciated IMD for thunderstorm warning during 2018 in its monthly magazine, Aapada Samvad, June, 2018
- **Appreciation** from various organisations for forecast for **pilgrimage and expedition in the Himalayan region during 2017 & 2018**

(v) Appreciation from President's House for successful forecast of rainfall over President"s Estate **on 26th Jan., 2019** during "**At Home Ceremony**" in New Delhi

(vi) Appreciations received for scientific publications.

- **Appreciation from Ministry of Earth Sciences**, Govt. of India for publication of Meteorological Monograph on cyclone, Ogni during 2008.
- **Appreciations from various agencies** including Indian Space Research Organisation and Indian Air Force for publication of Annual Report on Cyclonic Disturbances over the North Indian Ocean" during different years
- **Appreciations from various agencies** for publication of Standard Operation Procedure: Cyclone Warning Services in 2013

(e) Guest of Honour

1) Indian Meteorological Society and UNESCO with CSK Krishi Vishwavidhyalaya, Palampur organised "The South Asian Conference on Early Warning for Disaster Risk Reduction in Agriculture" during 25-26 October, 2017 at Palampur, Himachal. Dr. M. Mohapatra, Scientist-G and Head (Services) participated in the inaugural ceremony as distinguished **Guest of Honour** and delivered a lead talk on the "Weather Forecast and Warning Services for Mountain Regions of India-Problems and Prospects".
1) **Chief Speaker in the Valedictory function of** 9th National Seminar on "Water Resources Management in the context of Climate Change" **jointly organised by** Indian Climate Congress and Orissa University of Agriculture and Technology, Bhubaneswar on 28th February, 2018 at Bhubaneswar, Odisha.
2) **Guest of Honour** in the "The South Asian Conference on Early Warning for Disaster Risk Reduction in Agriculture" organized by Indian Meteorological Society and UNESCO with CSK Krishi Vishwavidhyalaya, Palampur during 25-26 October, 2018 at Palampur, Himachal and delivered a lead

talk on the “Weather Forecast and Warning Services for Mountain Regions of India-Problems and Prospects”.

3) **Keynote Speaker** in the 4th Persian Gulf Conference held in Tehran, I.R. of Iran during 17th-18th February, 2018 and presented the talk on “Monitoring, Forecasting and Early Warning System for Marine Weather Hazards.
4) **Guest of Honour** in the Inaugural Ceremony of "Centre for Environment and Climate" in Siksha O Anusandhan (SOA) University, Bhubaneswar on 23rd March, 2018.
5) **Guest of Honour** in the “ISRO Structured Training Programme” and delivered an invited talk on “New Trends in Remote Sensing & GIS for weather & climate studies” at IIRS Dehradun on 28th May, 2018.
6) **Guest of Honour** in the training Workshop on "Extreme Weather Events over India--Observations, Assimilation and Modeling with special focus on Tropical Cyclones" organized by IMD and IIT Bhubaneswar during 18-25 June, 2018 at IIT Bhubaneswar.
7) **Honorary Guest** in the Valedictory Ceremony of the Special Training course on "Remote Sensing & GIS Applications" organized by ISRO on 10th August, 2018 at Dehradun and a lecture on "Weather Forecasting &Related Services".
8) **Guest of Honour** in the Valedictory Function of the National Training Workshop on Disaster Risk Reduction organized by VV Giri National Labour Institute (VVGNLI), Noida and NIDM, MHA, New Delhi on 28th June 2019 and delivered an **Invited Talk** on cyclone warning services.
9) **Chief Guest** in the inaugural ceremony of the “National Conclave of Climate Change and Water” at CSIR IIMT Conference Hall, Bhubaneswar, Odisha and delivered Key Note Address during the occasion on 19th Oct., 2019.
10) **Chief Guest** in the Scholar Badge Ceremony of students at Delhi Public School, R K Pram, New Delhi on 3rd December, 2019.
11) **Chief Guest** during 13th Annual Review Meeting of Gramin Krishi Mausam Sewa (GKMS) & FASAL on 18th Dec., 2019. Delivered talk on role of Agromet Advisory Services in recent years in managing crop/live stock.
12) **Chief Guest** in the International Conference on Ensemble Methods in Modelling and Data Assimilation (EMMDA) on 24th February, 2020 at NCMRWF, NOIDA.
13) **Guest of Honour** in the 6th International Conference on Climate Services organized by Indian Institute of Tropical Meteorology, Pune, on 11th February, 2020.
14) **Guest of Honour** at Joint Webinar organized by IMD & NIDM on “Cyclones & Storm Surges” on 28th July, 2020.
15) **Distinguished Guest** in the Webinar on Thunderstorm and Lightning by NIDM on 14th July, 2020.
16) **Guest of Honour** in Conference on “Climate Change, Disasters & Sustainable Livelihood” organized by Department of Geography, University of Allahabad, Prayagraj on 26th November, 2020
17) **Guest of Honour** in valedictory function of Students Engineering Model Competition 2020 organized by CSIR - Central Electronics Engineering Research Institute, Pilani, Rajasthan on 24th December, 2020.
18) **Chief Guest** in Farmers Innovation Expo-2021 organized by College of Agriculture, Meghalaya as on 7th April, 2021.
19) **Chief Guest** in the Meet the Alumni Ceremony organized by Alumni Association, Utkal University on 24th July, 2021.

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