

Report of
One-Day Brainstorming Workshop/Panel Discussion

On

Organization of Convection, Tropical Storms, Disturbances,
and Extreme Weather

07 July 2025



Organized by



International Commission on Tropical Meteorology (ICTM) &
International Association of Meteorology and Atmospheric Sciences
(IAMAS)



In Association With



Advanced Centre for Atmospheric Radar Research (ACARR)
Cochin University of Science and Technology

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Hosted by

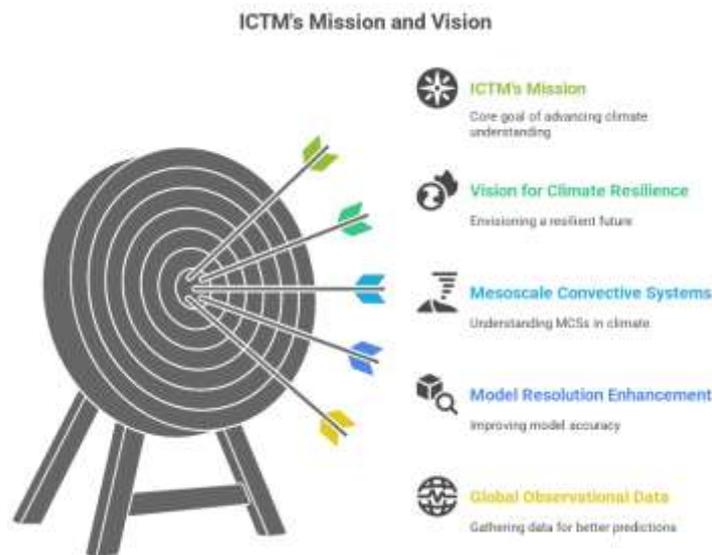
Department of Atmospheric Sciences (DAS), CUSAT

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Prologue

The one-day brainstorming workshop and panel discussion on "Organization of Convection, Tropical Storms, Disturbances, and Extreme Weather" brought together a vibrant community of scientists, researchers, and students from around the world. Organized under the aegis of the International Commission on Tropical Meteorology (ICTM), IAMAS, in partnership with Cochin University of Science and Technology (CUSAT), the event provided a dynamic platform for interdisciplinary dialogue on tropical meteorological phenomena.



A total of 123 participants attended the event, with 68 appearing offline at the CUSAT campus and 55 joining online via Zoom and YouTube. The hybrid format allowed for broad engagement across institutions and continents, enabling rich exchanges of knowledge and experiences. The workshop featured keynote talks, thematic lectures, and multiple panel discussions that focused on critical topics such as cloud organization, extreme weather prediction, and mesoscale convective systems.

Bridging Perspectives in Tropical Weather Research



This gathering was not just a dissemination of knowledge but also a convergence of perspectives aimed at shaping the future of tropical weather research. The day was marked by passionate discussions, deep insights, and the emergence of new ideas, with a

special emphasis on mentoring early-career scientists and fostering international collaboration.



Figure 1: Glimpses of workshop

1. Inaugural Session

Time: 9:30 AM

Chair: Dr. Thara Prabhakaran, Chairperson, ICTM

Dr. Thara Prabhakaran, Scientist G, Indian Institute of Tropical Meteorology (IITM), Pune, India, is the Project Director of Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) /Physics and Dynamics of Tropical Clouds (PDTC). Her areas of research include cloud microphysics and boundary layer processes, as well as cloud seeding research and development. Dr. Prabhakaran has extensive experience in planning and executing field campaigns using aircraft and ground-based instruments. She is establishing a centre of excellence for cloud physics and weather modification research. She has more than 150 peer-reviewed publications and has contributed to books, including a landmark WMO peer-reviewed report. She obtained her Ph.D. in 1996 from the University of Natural Resources and Applied Life Sciences (BOKU), Austria.



Figure 2: Inaugural session ICTM Zoom Panel

Dr. Thara Prabhakaran was a member of the International Commission for Clouds and Precipitation (ICCP) and a WMO Weather Modification Expert Team Member. She is currently a steering group member of the WMO - World Weather Research Programme (WWRP) Urban Prediction Project and a Member of the WMO/WWRP Steering Group of the Integrated Hydro&Precip project. She is the recipient of the Anna Mani Award of the Ministry of Earth Sciences and a fellow of the Indian Meteorological Society. She is also the Chairperson for the planning of the new International Commission on Tropical Meteorology (ICTM) under the auspices of IAMAS/IUGG.

The workshop began with a presentation by Dr. Thara Prabhakaran, a contributing member of the ICTM under the International Union of Geodesy and Geophysics (IUGG/IAMAS). She provided a brief overview of the aims and objectives of ICTM, which seeks to promote international collaboration and research on tropical meteorological processes. In her talk, Dr. Thara addressed the organisation of convection and its influence on tropical storms, disturbances and extreme weather events. She explained how spontaneous clustering of convection affects storm dynamics and contributes to uncertainties in climate models. Observational studies indicate that a warming climate leads to more organised convection, producing fewer but more intense storms with heavier precipitation. The presentation emphasised the significance of mesoscale convective systems (MCSs) in driving such extremes, as well as the challenges involved in observing and simulating these complex processes. Dr. Thara concluded by stressing the need to enhance model resolution and observational data coverage, while reinforcing ICTM’s role in fostering global dialogue on tropical meteorology.

International Association of Meteorology and Atmospheric Sciences (IAMAS/IUGG)
International Union of Geodesy and Geophysics

IAMAS is one of the eight associations of IUGG:

- **Meteorology and Atmospheric Sciences**
- Cryospheric Sciences
- Geodesy
- Geomagnetism and Aeronomy
- Hydrological Sciences
- Physical Sciences of the Oceans
- Seismology and Physics of the Earth’s Interior
- Volcanology and Chemistry of the Earth’s Interior

- IAMAS promotes research in atmospheric sciences requiring international collaboration
- IAMAS leads the Alliance for Capacity Transfer (ACT) – a joint activity of IUGG, the World Meteorological Organisation (WMO), and the University Corporation for Atmospheric Research (UCAR).
- Voluntary efforts of scientists
- The science is carried out by our 10 +1 commissions

People:

- Past president
- past SC
- 5 Members at Large
- chair of ECS

Andrea Pizzetti, President

Keith Amis, Secretary-General

John Thomas, Vice President

Hans Thurner, Vice President

Figure 3: Dr. Thara Prabhakaran's talk

2. Keynote Address

Speaker: **Dr. Brian Mapes, University of Miami**

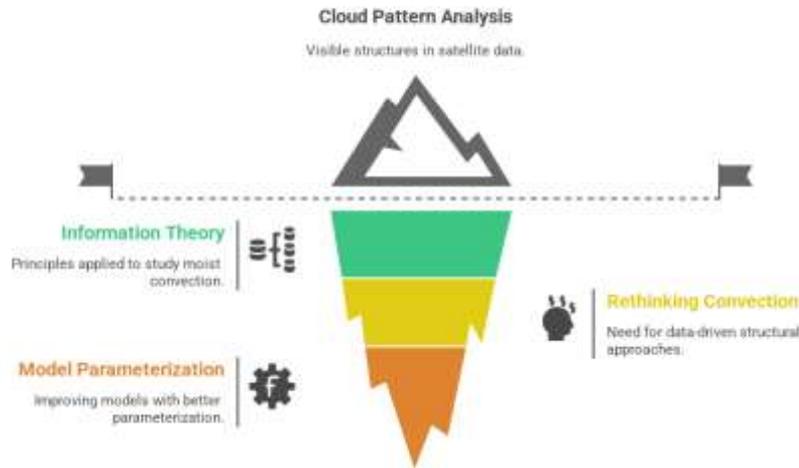
Title: **"What does self-organizing horizontal cloud pattern information reveal about the vertical process parameters of moist convection?"**

Dr. Brian Mapes is a Professor in the Department of Atmospheric Sciences at the University of Miami’s Rosenstiel School of Marine, Atmospheric, and Earth Science. Mapes is an expert on atmospheric dynamics and thermodynamics, especially the interactions between cloudy convection and larger-scale weather patterns. He received his PhD from the University of Washington in 1992. Dr. Mapes has significantly contributed to our understanding of atmospheric convection, its interactions with large-scale dynamics, and its role in shaping regional and global weather and climate. The role of atmospheric convection and the impact of these convective storms on weather and climate across large regions (such as India and the subtropics) is a focus of Mapes’ research. Tropical weather especially depends on convection, so some of his research projects focus on seasonal monsoons as well as travelling weather ‘waves’. Dr. Mapes also works to advance information technologies relevant to convection science.



Figure 4: Dr. Brian Mapes presenting his keynote address in ICTM

Unveiling the Depths of Moist Convection.



Dr. Brian Mapes presented an engaging talk titled **“What Does Cloud Pattern Information Reveal About the Vertical Process of Moist Convection?”** His presentation critically examined how information theory and cloud pattern analysis can help reveal the organisation of convection, drawing parallels between atmospheric science and ecological systems. Using concepts like entropy, information compression and scene characterisation, he explored how satellite imagery and radar data could be used to identify meaningful structure in convective systems, especially mesoscale convective systems (MCSs). He highlighted challenges in interpreting log-log scaling plots, the risks of false pattern interpretation and the need to revisit traditional assumptions about convective organisation. Dr. Mapes proposed that the organisation of convection may resemble ecological succession, emerging from clean slate atmospheric conditions and stressed the importance of tracking cell adjacency and storm structure over time. The talk also touched on the implications for numerical weather prediction and general circulation models (GCMs), especially regarding how convection is parameterised. Overall, his presentation encouraged rethinking how cloud pattern data is used to understand and simulate tropical convection.

3. Thematic Talk

Speaker: **Dr. K. Rajeev, Former Director, SPL, VSSC**

Title: **"Tropical Clouds: Distribution, Energetics & Feedback Effects"**

Dr. K. Rajeev is the former Director and Distinguished Scientist at Space Physics Laboratory (SPL), Vikram Sarabhai Space Centre (VSSC), ISRO, Thiruvananthapuram. His expertise lies in Atmospheric Science, focusing on areas such as Atmospheric Aerosols, Clouds, Radiation Transfer, Boundary Layer Physics, Atmospheric Dynamics, and Climate Change. He also specializes in Satellite and Lidar remote sensing & inversion methods. Dr. Rajeev obtained his Ph.D. in Physics from SPL,

VSSC/University of Kerala and did his Post-Doctoral Research at the Scripps Institution of Oceanography, San Diego, USA.



Figure 5: Dr. K. Rajeev delivering his thematic talk

He is the national representative to the COSPAR council and a member of the Research Advisory Committee of the Indian Institute of Geomagnetism, Mumbai and the Indian Institute of Tropical Meteorology, Pune. Dr. Rajeev has made significant discoveries, and his scientific findings on aerosols, clouds, and radiative impacts have been highlighted by both ISRO and the NASA Earth Observatory. Through his roles at VSSC and participation in national and international research, Dr. Rajeev has made significant contributions to atmospheric and space science research.

He was the first to quantify vertical distributions of convective clouds over India, and his discovery of the “pool of inhibited cloudiness” over the Bay of Bengal offered new perspectives on monsoon dynamics. Notably, his work has led to direct observational evidence of radiative forcing by aerosols - an achievement highlighted in a NASA Earth Observatory press release as breaking scientific news. He has held key leadership roles in programs linked to Chandrayaan-2, Gaganyaan, and atmospheric research testbeds, and continues to shape national strategy through academic, review, and implementation committees across ISRO, DST, and MoES.

Dr. Rajeev is also widely known for his outreach. He has delivered over two dozen popular and invited talks, ranging from direct broadcasts on DD Malayalam to sessions at the India International Science Festival, academic symposia at Scripps, and skill-building events at IITM and ISRO centres. This blend of technical depth and public engagement underscores his role as both a researcher and a science communicator.

The workshop featured a comprehensive presentation by Dr. K. Rajeev on *“Tropical Clouds: Distribution, Energetics and Feedback”*. This presentation explored the critical role of tropical clouds in Earth’s energy balance, hydrological cycle, and climate feedback mechanisms. He emphasised the thermodynamic nature of atmospheric water, emphasising its role in atmospheric energy transfer and greenhouse warming. Using satellite data from CloudSat, CALIPSO, Megha-Tropiques, and INSAT, Dr. Rajeev illustrated patterns in cloud formation, radiative forcing and the influence of sea surface temperatures, showing distinct behaviours for low and deep convective clouds. Special attention was given to the complexities of monsoon cloud structures and their feedback mechanisms. The presentation also highlighted recent findings on cloud penetration into the lower stratosphere and the implications of cloud variability for climate modelling. Overall, the talk provided deep insights into the atmospheric processes governing tropical cloud systems and their broader climatic significance. This work underscores the need for continued high-resolution satellite monitoring to improve understanding and modelling of cloud-climate interactions.



Figure 6: Honoring Dr. K. Rajeev

Following the thematic talk, Dr. K. Rajeev was felicitated in recognition of his decades of scientific leadership, mentorship, and service to Indian atmospheric research. He was presented with a memento and ‘ponnada’ by Prof. (Dr.) C.A. Babu (Adjunct Professor) and Prof. (Dr.) Satheesan K, Department of Atmospheric Sciences (DAS), CUSAT.

4. Panel Discussion I:

Tropical Convection and Organization of Clouds

The first Panel Discussions commenced at 11:30, following a short break. The topic of the first Panel was ***“Tropical Convection and Organization of Clouds”***, focusing on a theme that lies at the very heart of tropical meteorology - the structure and organization of convection and cloud systems. There were two speakers in this panel discussion. The session was **chaired by Prof. (Dr.) C.A. Babu (Adjunct Professor)**, Department of Atmospheric Sciences, CUSAT.

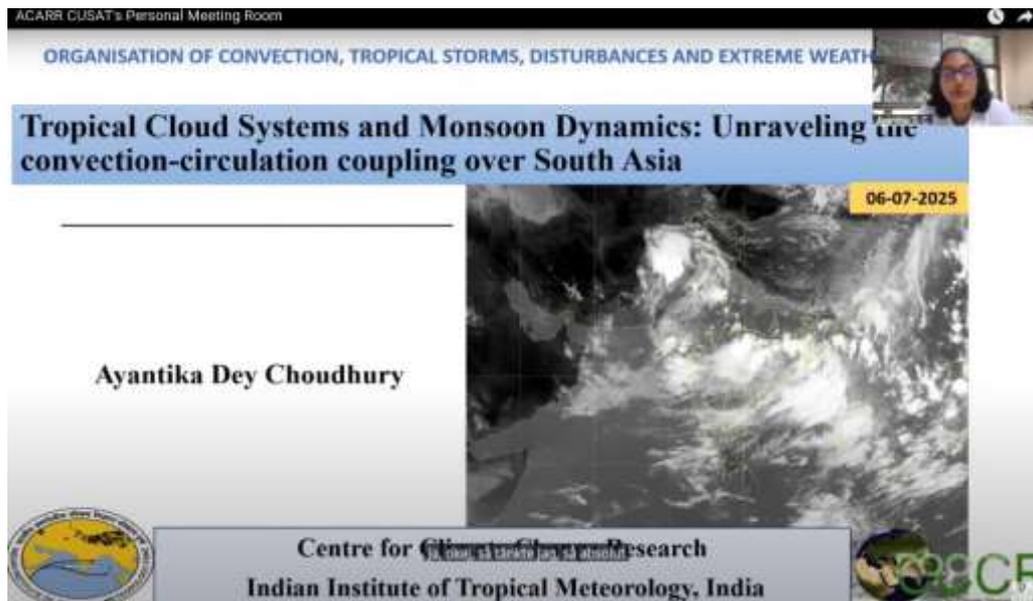


Figure 7: Dr. Ayantika in Panel Discussion I

The first panelist in the discussion was **Dr. Ayantika Dey Choudhury, Scientist E** at the **Centre for Climate Change Research of IITM, Pune**. Her research focuses on South Asian Monsoon Dynamics and variability, Extreme precipitating systems and climate change, and Earth System Modelling. She has done fundamental research work, using atmospheric model simulations and diagnostic analysis of observations, highlighting the critical role of the vertical distribution of latent heating of monsoon convective cloud systems in influencing the summer monsoon circulation. Additionally, Dr Ayantika has contributed to the development of the IITM-ESM – the first climate model from India that participated in CMIP6, and currently serves as a member of the WCRP Global Precipitation EXperiment (GPEX) Working Group on precipitation modelling. She has a PhD in Atmospheric Science from the University of Pune.

Dr. Ayantika Dey delivered an online talk titled ***“Tropical Cloud Systems and Monsoon Dynamics: Unravelling the Convection-Circulation Coupling over South Asia.”*** She discussed the interplay between large-scale monsoon circulation, atmospheric convection, and mesoscale convective systems (MCS), which act as a crucial link between the two. Evolution of heavy precipitating systems occurs within the envelope of monsoon circulation, through complex feedbacks involving circulation,

moisture and MCS heating fields across different spatial and temporal scales. Top-heavy stratiform heating plays a key role in intensifying mid-tropospheric circulation and potential vorticity stretching, increasing the risk of extreme rainfall over large areas. Climate modes like the Indian Ocean Dipole (IOD) further enhance cross-equatorial moisture transport and deep convection over the subcontinent, favoring stratiform precipitation. However, Dr. Dey noted that current models exhibit significant biases in representing vertical latent heating profiles, affecting monsoon simulations. Enhanced multi-platform observational networks, process-level diagnostics, high-resolution modeling, and AI/ML methods are essential for better capturing the mesoscale convection and its interaction with monsoon circulation over South Asia.

The second panelist was **Dr. E. A. Resmi, Scientist E & Group Head, Atmospheric Science Group (ASG), National Centre for Earth Science Studies (NCESS), Thiruvananthapuram.** Dr Resmi is engaged in front-line research in cloud-microphysics for improving the accuracy of precipitation estimation in complex regions like the Western Ghats provinces of Peninsular India.



Figure 8: Dr. Resmi E. A. in Panel Discussion I

She has been instrumental in setting up a **High Altitude Cloud Physics Observatory (HACPO) at Rajamallay, Munnar** and the upgradation of the Braemore observatory in Thiruvananthapuram. She also contributed immensely to the establishment of the Lightning Detection Network on the southwest coast of India in collaboration with IITM, Pune and IMD. Dr. Resmi and her colleagues were able to bring out clearly the seeder-

feeder mechanism in the southern Western Ghats region during the monsoon season. She has also worked in the area of air quality monitoring and its diurnal cycle over a coastal location as a part of the ‘Modelling Air Pollution and Networking’ (MAPAN) programme of the Ministry of Earth Sciences, Government of India. She holds a PhD in Atmospheric Sciences from CUSAT and was awarded the Certificate of Merit 2020 by the MoES, Govt of India.

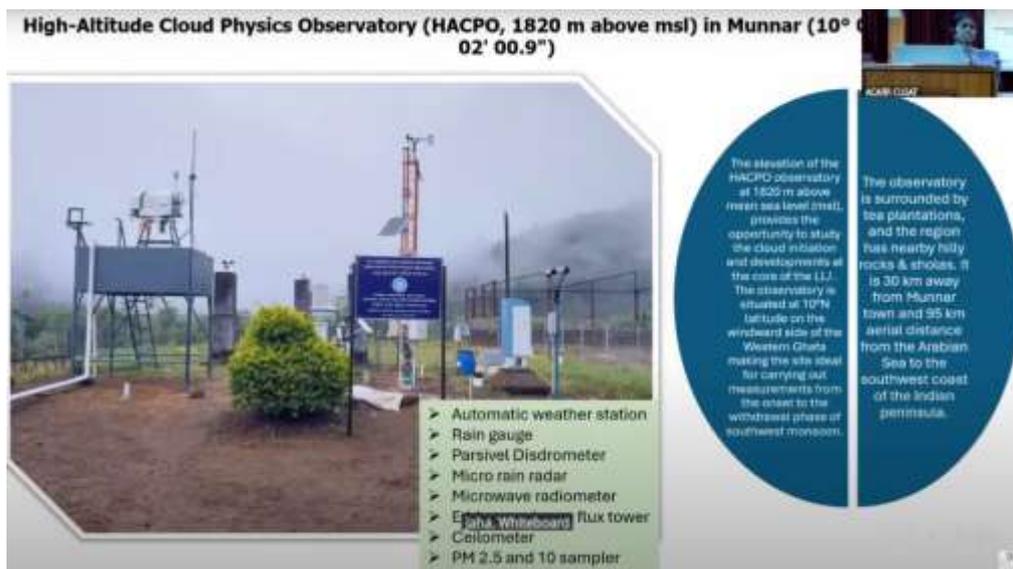
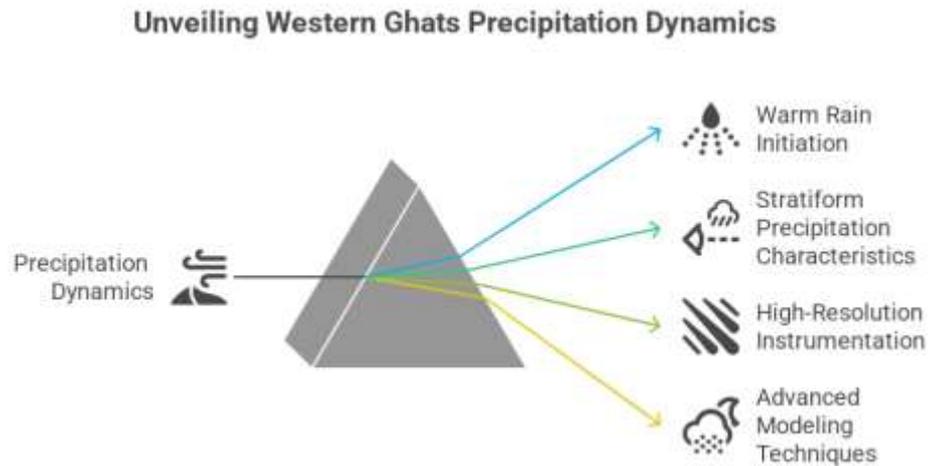


Figure 9: NCESS's HACPO in Munnar

Dr. Reshmi delivered the talk on ***“Precipitation Microphysics in Organized Mesoscale Systems: The role of warm clouds”***. The warm rain mechanism in the tropics and challenges in resolving warm rain or shallow convection in numerical simulations were presented in this talk. It was focused on the warm rain initiation in organized convection systems during the monsoon season of 2018 and 2019. The studies pointed out that stratified cloud layers are invigorated in the stratiform precipitation over the Western Ghats, leading to the occurrence of intense shallow and mixed-phase precipitation, and precipitation microphysics confirms the size-controlled and number-controlled processes in stratified precipitation layers. Dr. Reshmi pointed out that a

combination of satellite, radar and ground-based instrumentation will be useful to identify the shallow echoes formed in the monsoon season. The formation of shallow echoes is largely controlled by the regional factors as well as mesoscale dynamics. How the shallow systems are producing prolonged heavy rain echoes is an unresolved problem. Thermodynamic processes underlie the warm rain mechanism, and for the improved understanding of the cloud-to-rainwater conversion processes in the models, they are the need of the hour.

5. Panel Discussion II: Extreme Weather Events

The second panel discussion on “**Extreme Weather Events**”, one of the most pressing topics in meteorology today, commenced at 14:00 after the lunch break. From high-impact rainfall to tropical cyclones and polar cloud systems, extreme events are increasing in frequency and intensity, challenging our forecasting systems and resilience frameworks. There were three speakers in this panel discussion, and the session was **chaired by Prof. (Dr.) K Satheesan**, Department of Atmospheric Sciences, CUSAT.



Figure 10: Dr. Uma K. N. during Panel Discussion II

The first panelist was **Dr. Uma K. N., Scientist ‘SF’, at SPL, VSSC, Thiruvananthapuram**. She holds a PhD in Atmospheric Science from S.V. University, Tirupati. Her research primarily focuses on atmospheric dynamics, with special emphasis

on tropical mesoscale convective systems and their associated dynamics. She investigates key dynamical phenomena such as stratosphere–troposphere exchange processes, gravity wave generation and propagation, and their broader implications for upper atmospheric circulation. Her expertise extends to the use of ground-based radar systems and satellite remote sensing techniques for observing and characterizing mesoscale convective systems. Through her contributions, she aims to improve the understanding of the vertical coupling processes in the atmosphere and enhance the detection and analysis of mesoscale weather events using advanced observational platforms.

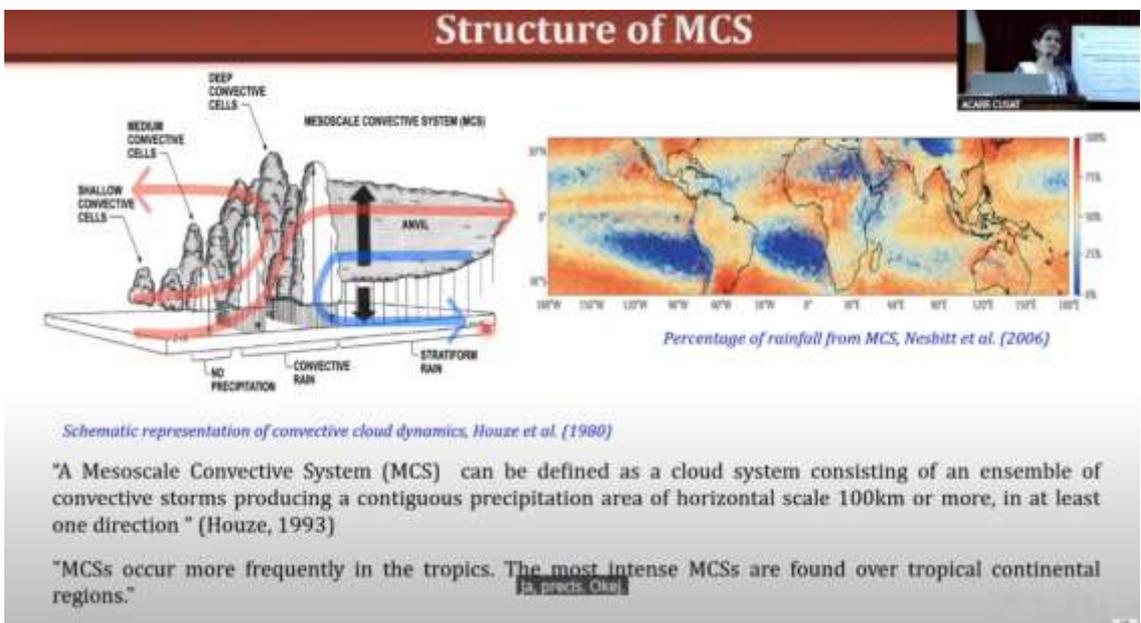


Figure 11: Glimpses of Dr. Uma's talk

Dr Uma delivered a presentation titled ***“Tracking the Rhythm of the Storms: A Perspective from Radar Observations”***. She provided an in-depth radar-based analysis of convective systems, focusing on three key case studies: monsoon convection over

Thiruvananthapuram (Thumba), a pre-monsoon hailstorm event over Kolkata and a cyclonic storm near Chennai. Drawing from ground-based data, she illustrated the structural, temporal and microphysical characteristics of storms in each scenario. The study highlighted how environmental parameters like wind shear, CAPE and humidity influence storm morphology and evolution. Her analysis emphasised the variability in convective intensity and behaviour across different regions and weather regimes. Dr. Uma highlighted the need for integrated observational strategies, combining high-resolution ground-based radar with spaceborne observations, to improve our understanding of cloud dynamics and precipitation processes critical to accurate weather and climate forecasting.



Figure 12: Dr. Jayakumar A. delivering his talk in Panel Discussion II

The second speaker in this panel was **Dr. Jayakumar A, Scientist-E, leading the Atmospheric Modelling Group of the National Centre for Medium Range Weather Forecasting (NCMRWF)**. Dr. Jayakumar has played a key role in adapting the recent NCMRWF Unified Modelling system from the UK Met Office. He led the development of the NCMRWF version of the seamless prediction system, enabling convection-permitting scale to urban resolution models.

Dr. Jayakumar is the Principal Investigator from India for the Weather and Climate Science for Service Partnership India-UK (WCSSP-India) sub-km modelling project under the Newton-Bhabha Fund. He developed the DM-Chem model for high-resolution PM_{2.5} and visibility forecasts for Delhi and the NCR regions. He serves as the Co-PI of the

Monsoon Mission project phase III with CAOS, IISc, focusing on surface energy balance and boundary layer characteristics in Monsoon Mission models. Some of his major contributions include the development of visibility parameterization in the high-resolution Delhi model for fog forecasting, a revised lightning forecast formulation, and the development of the urban canopy scheme using Delhi's morphology data. Dr. Jayakumar was awarded the Certificate of Merit by the Ministry of Earth Sciences in 2018.

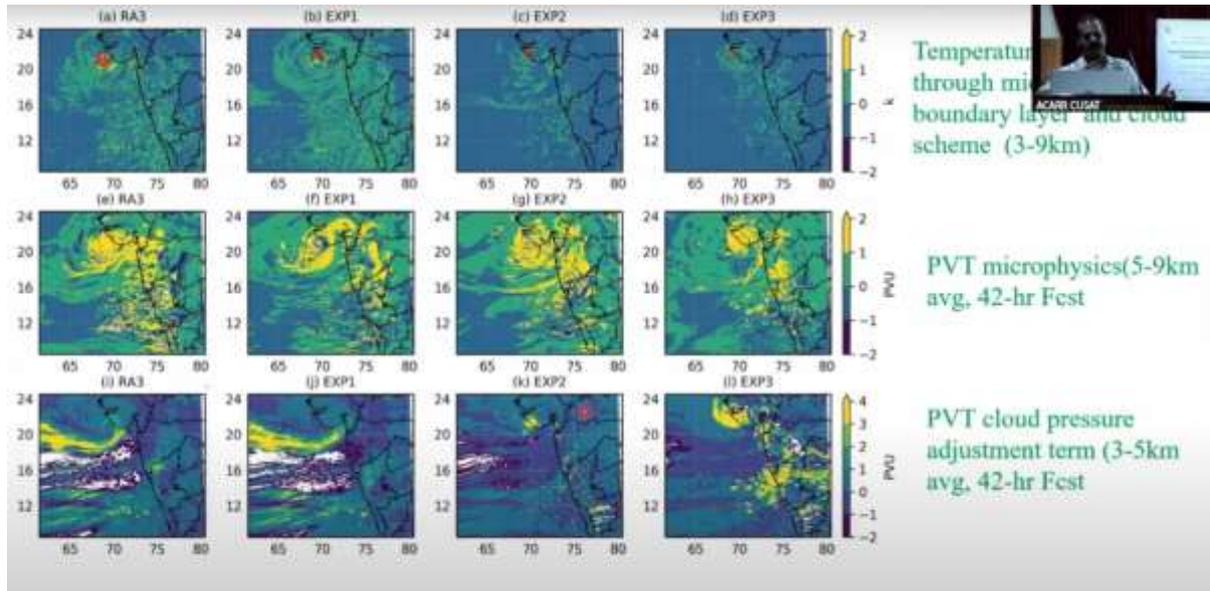


Figure 13: Glimpses of Dr. Jayakumar's talk

The topic of Dr. Jayakumar was ***“Impact of Cloud Microphysics on the Track Prediction of Tropical Cyclone (Vayu) in a Convective-Scale Model”***. Using a high-resolution 4 km convection-permitting model, his team analysed how advanced cloud microphysics schemes, particularly CASIM and a bimodal cloud representation, improved the cyclone track prediction. The study highlighted the sensitivity of cyclone structure to ice fall speed, latent heating and cloud hydrometeor distributions. Comparison with older models showed that the new physics significantly reduced track prediction errors, especially during recurvature. The role of latent heat release in altering atmospheric dynamics and the vertical distribution of heating was key to realistic cyclone motion simulation. Their work highlights the importance of microphysical processes in improving early warnings for extreme weather events.

The third speaker of this panel discussion was **Dr. Sreenath A. V., Postdoctoral research fellow, Monash University, Australia**. His work is dedicated to advancing the understanding of convective cloud systems over the Southern Ocean. As part of the Securing Antarctica’s Environmental Future (SAEF) project, his research focuses on the dynamics of open and closed mesoscale convective clouds. Dr. Sreenath is exploring their interactions with atmospheric dynamics and thermodynamics, as well as the impact of climate change on Antarctic environmental conditions. He was awarded his PhD in Atmospheric Science from CUSAT in 2023.

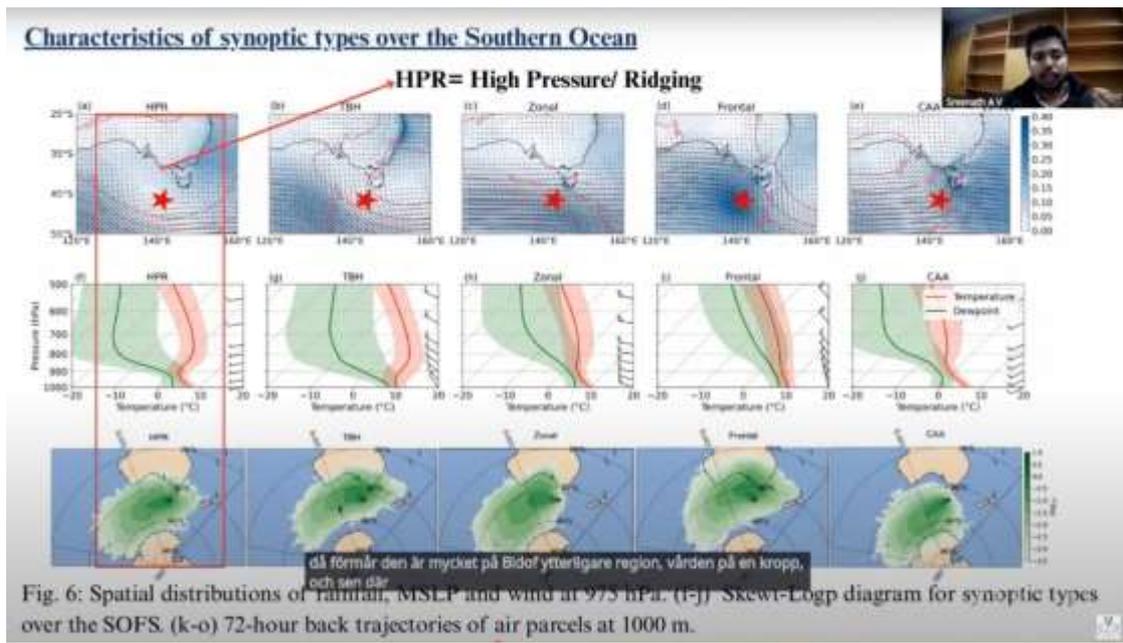


Figure 14: Dr. Sreenath delivering his talk in Panel Discussion II

Dr. Sreenath talked about **“The impact of synoptic meteorology on observed surface heat fluxes and boundary layer clouds over the Southern Ocean”** in online mode. A 14-year climatology of the sensible and latent heat fluxes (SHF and LHF) from the Southern Ocean Flux Station (SOFS) was analyzed with respect to synoptic meteorology and mesoscale cellular convection (MCC). Using K-means clustering, five synoptic regimes were identified: High Pressure/Ridging (HPR), Tasman Blocking High (TBH), Zonal, Frontal, and Cold Air Advection (CAA). Among these, CAA showed the strongest air-sea coupling, with mean SHF of -40.4 W/m^2 and LHF of -131.0 W/m^2 , which are 3.5 and 2 times greater than the overall mean, respectively. This striking increase was associated with a high marine cold-air outbreak index (M-index) and weak inversion coupled with cold and dry air transport towards SOFS by the strong south-westerly wind. ERA5 data matched SOFS observations well, with minimal bias and high correlation ($r = 0.9$ for SHF, 0.92 for LHF). Comparisons between open and closed MCC showed minor differences in surface fluxes, indicating SHF and LHF are not primary drivers of MCC transitions. The study showed that open MCC had strong M-index–flux correlations, while closed MCC occurred in more stable conditions with weaker M-index influence.

6. Panel Discussion III: Observations and Modelling of Convective Storms

The final panel discussion and Action Plan on “**Observations and Modelling of Convective Storms**” commenced after a break at 15:30. This panel brings together emerging and established voices working on the observation, analysis, and modelling of convective storms.



Figure 15: Dr. Parthasarathi Mukhopadhyay in Panel Discussion III

The first speaker of the panel was **Professor Parthasarathi Mukhopadhyay**, who was present in online mode. Prof. Mukhopadhyay is a **Visiting Faculty member at the Indian Institute of Science Education and Research (IISER), Berhampur**. Prof. Parthasarathi Mukhopadhyay has deep expertise in the development of high-resolution numerical models and physical parameterizations, particularly cloud convection and cloud microphysics. His research focuses on extreme precipitation forecasting, high-resolution ensemble prediction systems, and the prediction of intra-seasonal oscillations in the monsoon. He also contributes to developing wind and solar energy forecasts. Prof. Mukhopadhyay **retired as Scientist-F from IITM, Pune**, where he led the indigenous development of a 6.5 km resolution Indian global model over the tropics. He also headed the NITI Aayog Departmental Action Plan of the Ministry of Earth Sciences on developing a high-resolution (12km) Global Ensemble Weather Forecast Model.

Dr. Mukhopadhyay was elected Fellow of the Indian Academy of Sciences (FASc) in 2023 and Member of the WMO Weather Research Programme working Group on Tropical Meteorology Research (WGTMR). He is also the recipient of the Certificate of Merit by MoES in 2015.

Prof. Mukhopadhyay discussed the topic “**Challenges in Representing Convection in NWP Models**”, particularly highlighting the persistent scale gap that arises due to limitations in parameterizing or resolving mesoscale convective systems (MCS). Since convection operates at sub-grid scales, it cannot be explicitly resolved by current atmospheric models and must therefore be parameterized. The presentation emphasized

the complexity of cloud–radiative interactions, especially the feedbacks between stratiform and convective clouds, which are inadequately captured in existing models and lead to poor representation of diurnal to synoptic scale processes. The speaker stressed that conventional models fail to capture the hierarchical coherence of organized convective systems, ranging from cumulus clouds to superclusters, necessitating multiscale approaches. To improve model performance, he suggested the adoption of multiscale cloud and convection approaches, stochastic techniques, and better treatment of cloud-radiative feedback. Furthermore, recent advances such as AI/ML-based hybrid models were noted as promising tools in bridging current gaps, as supported by several studies. The talk concluded by underscoring the importance of coupling Earth system components, utilizing advanced data assimilation techniques, and addressing error propagation across scales to enhance the predictive capabilities of NWP models.



Figure 16: Glimpses of Dr. P. Mukhopadhyay's talk

The second panelist was **Mr. Nandulal K**, a **Project Fellow** pursuing a Ph.D. in Atmospheric Science at the Department of Physics, **Sree Krishna College, Guruvayur, Kerala**. His research focuses on lightning and convective activity over Kerala, with a particular emphasis on the influence of dynamic and thermodynamic drivers. He investigates the spatial and temporal variability of lightning in the region, aiming to identify key precursors and influencing factors. His work also examines the recent changes in lightning patterns over Kerala.

Mr. Nandhulal presented a topic on ***“Spatial and Temporal Characteristics of Lightning Activity over Kerala and its Dynamical and Thermodynamical Attributes”***. This study investigates the spatiotemporal variability of lightning activity over Kerala during the period 1998–2013, and its association with key dynamical and thermodynamical parameters. A peak in lightning activity was observed during April, with hotspot regions in Kottayam and Idukki districts, experiencing over 70

flashes/km²/year, while regions west of the Palakkad Gap show significantly lower activity. He examined diurnal, seasonal, and spatial patterns of lightning using climatological data and correlates lightning frequency with Convective Available Potential Energy (CAPE), K Index (KI), vertical velocity (omega) SST, and moisture transport patterns. A strong spatial and temporal correlation was observed between lightning activity and CAPE, KI, and omega, particularly in regions with strong updrafts. SST values above 29.6°C are found to significantly enhance convective activity. Moisture transport analysis highlights the role of Bay of Bengal and the Arabian Sea as key sources during different parts of the year. The results underscore the importance of regional geography, atmospheric instability, and ocean-atmosphere interactions in governing lightning distribution over Kerala, contributing to better forecasting and risk management.



Figure 17: Mr. Nanshualal's talk in discussion III

The third panelist of the session was **Ms. Silpamol D. S.** She is a **Junior Research Fellow at the Advanced Centre for Atmospheric Radar Research, CUSAT.** She holds an M.Sc. in Meteorology (2022) from CUSAT. Her research primarily focuses on mesoscale convective systems, monsoon heavy rainfall events, and satellite-based weather observation and analysis. She is actively involved in the study of atmospheric processes that influence extreme weather over the southwest coast of India. She utilizes high-resolution satellite data to track and characterize convective systems associated with the Indian monsoon.

Ms. Silpamol presented her work on ***“Characteristics of Mesoscale Convective Systems during Monsoon Extreme Rainfall Events: Case Studies from the Southwest***

Coast of India”. The study analyzes the characteristics of Mesoscale Convective Systems (MCS) associated with extreme rainfall events along the southwest coast during 2018, 2019, and 2024, which led to widespread flooding and other natural hazards. MCS was tracked from the MSG2 SEVIRI satellite brightness temperature IR imagery. It was found that MCS during these events were extensive and well-organized, primarily affecting the southwest coast of India. The 29 July 2024 event was catastrophic, triggering an enormous landslide in Wayanad, a northern district of Kerala, claiming over 300 lives, with many others still unaccounted for. Compared to 2019, MCS in 2024 showed stronger coastal clustering. The study highlights that the transition from heavy to extreme rainfall over the southwest coast was tied to the presence of massive MCS, underlining the impact of climate change. She pointed out that continuous monitoring of MCS through satellite observation enables the identification of regions in Kerala susceptible to heavy rainfall, aiding in nowcasting.



Figure 18: Ms. Silpamol's talk in discussion III

7. Concluding Session

The proceedings were concluded with remarks and a vote of thanks by **Dr. Abhilash S., Director of ACARR, Head, Department of Atmospheric Sciences, CUSAT, and Coordinator** of this workshop. Dr. Abhilash opened the floor for any final thoughts or suggestions, upon which Prof. Mukhopadhyay extended his congratulations to the two student presenters for their commendable presentations. He encouraged young researchers to go beyond relying solely on well-established indices and methodologies, emphasizing that with the increasing availability of high-resolution datasets, students should not hesitate to develop novel indices and approaches tailored to their research contexts. He further suggested that convective systems should not be viewed in isolation but analyzed within the larger dynamical framework to yield more meaningful insights.



Figure 19: Dr. Abhilash delivering concluding remarks

Following this, **Dr. Abhilash** proceeded to formally conclude the proceedings by offering a concise yet comprehensive summary of the day's deliberations. He noted that although significant advancements have been made in the study of convective systems, their dynamics and impacts, the field remains filled with uncertainties, "the unknown still outweighs the known." This, he emphasized, presents a wide spectrum of unexplored research opportunities, particularly for early-career scientists. In closing, Dr. Abhilash extended his sincere gratitude to all the invited speakers, panelists, student presenters, and members of the organizing committee for their valuable contributions and support in making the workshop a meaningful and successful event.

The moderators for the sessions were Dr. Smitha A, Project Scientist, ACARR and Ms. Stefy Thomas, Research Scholar, DAS, CUSAT.



Figure 20: Group photo of workshop

Coordinator: Dr. S. Abhilash (CUSAT).

Support: ICTM Executive Committee members

Logistics: Local host (DAS CUSAT)