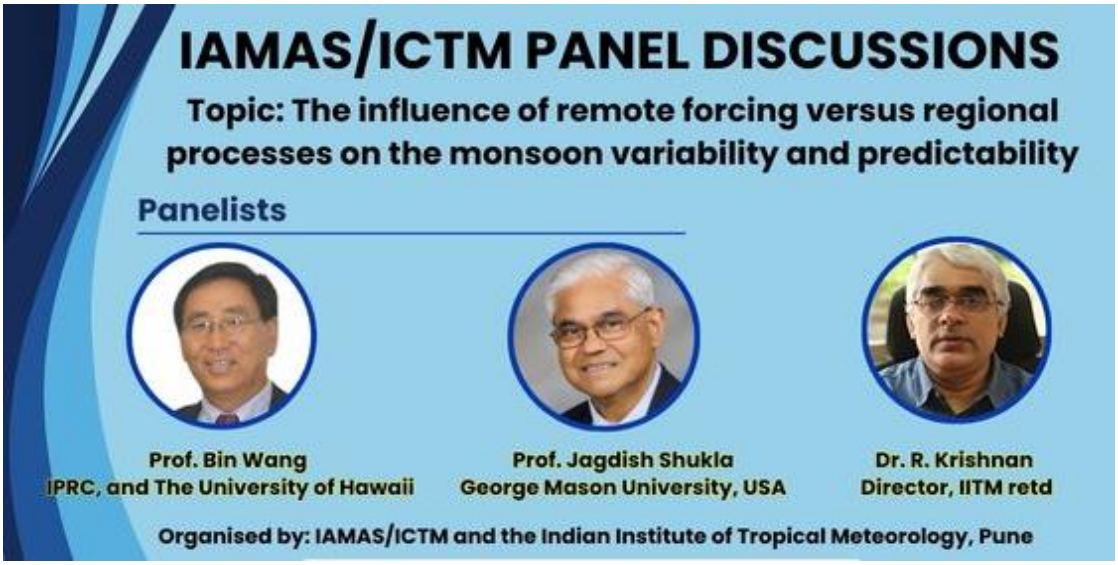
Report on IAMAS/ICTM-IITM Panel Discussion

Panel discussion Theme: The Influence of Remote Forcing Versus Regional Processes on Monsoon Variability and Predictability

Date: Tuesday, May 27, 2025
Time: 18:30 IST
Platform: Online Webinar

Organizers:

- IAMAS: International Association of Meteorology and Atmospheric Sciences
- ICTM: International Commission on Tropical Meteorology (under formation)
- IITM: Indian Institute of Tropical Meteorology



Moderators:

- Dr. Sabin T. P., IITM
- Dr. Smrithi Gupta, IITM

Panel Discussion Summary:

The second panel discussion in the IAMAS/ICTM series was convened to explore the evolving dynamics between remote forcing and regional processes in shaping monsoon variability and predictability. Dr. Thara Prabhakaran of IITM opened the session by outlining the objectives of ICTM, including fostering tropical meteorology research, enhancing circulation system understanding through modeling and observations, promoting international scientific collaboration, and supporting student participation in related events.

First Round: Opening Remarks by Panelists

Prof. Bin Wang emphasized that predicting monsoon climate is becoming increasingly challenging due to global warming. One of the main reasons is the evolving characteristics of ENSO, the primary source of the predictability. Since 1980, the onset of El Niño has shifted from the eastern Pacific to the western Pacific, resulting in more frequent Super and Central Pacific El Niño events, followed by increased frequency of multi-year La Niña events. The Asian summer monsoon response varies with different flavors of ENSO, depending on the intensity, as well as the developing and decaying phases, exhibiting complex regional and seasonal patterns. He pointed to the increasing persistence of Central Pacific La Niña episodes over multiple years, which poses new challenges to monsoon predictability. He also highlighted the increasing role of the Indian Ocean Dipole (IOD) in influencing large-scale circulation adjustments. On the modeling front, Prof. Wang noted that many existing models are inadequate for capturing Mesoscale Convective Systems (MCS), topography-induced convection, and the diurnal cycle - all essential features in understanding regional monsoon dynamics. He further cited the importance of remote influences, such as the Southern Annular Mode, Arctic sea ice variability, and snow cover changes, in the context of global warming.

Prof. Jagdish Shukla underscored the continued dominance of ENSO as a key remote driver of monsoon variability. However, he asserted that accurate and reliable predictions of summer monsoon rainfall would not be possible until models can realistically simulate both ENSO and SST over the Indian Ocean (viz IOD and Arabian Sea SST), and their impacts on circulation and rainfall. He stressed the importance of clearly separating ENSO effects from Indian Ocean processes ~~phenomena~~ in climate models. He also drew attention to the need for a deeper understanding of the active-break cycle of the monsoon, advocating for the use of dynamical instability theories because active and break cycles are always present, irrespective of SST changes. According to him, this theory remains a largely untapped resource that could significantly enhance sub-seasonal predictability~~. if better incorporated into weather and climate models.~~

Dr. R. Krishnan concentrated on the growing occurrence of compound weather and climate extremes in the Asian monsoon region, which are increasingly linked to both remote drivers and local triggers. He noted that the 2022 summer monsoon season was a clear example of compound hydrological extremes in the Asian region, wherein devastating floods occurred in the Indus River basin, while concurrent drought conditions and heatwaves prevailed in the Yangtze River basin. He noted that the evolving La Niña, Indian Ocean warming, pre-monsoon glacier melt, and saturated soils were key contributors to the Indus river basin heavy rainfall and floods during 2022. Dr. Krishnan argued for an Earth System approach to improve understanding and modeling of such extremes, while also stressing the need to evaluate the fidelity of current Earth System Models (ESMs) in simulating compound hydrological extremes.

Second Round: Focused Questions to Panelists

Have we fully understood the separation of remote versus regional influences?: Prof. Shukla responded that while much progress has been made, land-atmosphere feedbacks and Indian Ocean effects remain underrepresented in current models. He emphasized the need for event-based international model intercomparison efforts to assess model biases, especially during significant events. Collaborative modeling exercises, he said, could help refine the representation of coupled land-ocean-atmosphere processes. He recommended that ICTM initiate coordinated event-based

Model Intercomparison Projects (MIPs) to facilitate collaborative event/case studies and improve predictive capabilities.

How should we prioritize model improvements? Dr. Krishnan proposed using the year 2022 as a benchmark for evaluating the fidelity of current Earth System Models (ESMs) to capture compound weather and climate extremes in the Asian region. He also highlighted the need for multi model approach to evaluate the skill of ESMs in simulating monsoon extreme events, by involving many modelling groups across the world . Additionally, he stressed the need for high-resolution modelling with improved parameterization of key physical processes such as the large-scale organization of monsoon mesoscale convective systems which are central to extreme precipitation events in the Asian monsoon region.

What observational strategies or field campaigns are needed?: Prof. Wang highlighted the necessity for expanding observational infrastructure, particularly the density of radar and radiosonde networks in the monsoon region. He underlined that improved monitoring of MCS and other fine-scale phenomena is crucial for both model validation and real-time forecasting. He also emphasised the need of regional collaboration for enhanced data sharing.

Additional Scientific Insights from panelists:

- Convective-stratiform partitioning needs better representation in models.
- Climate change may alter dominant convective modes.
- The role of southern annular mode, Atlantic variability, and Arctic processes in intraseasonal monsoon variability needs thorough study.
- Land use change and the potential emergence of "no-sea-ice epochs" may significantly shift boundary forcing.

The panel concluded with each expert providing actionable recommendations for ICTM.

Actionable Recommendations for ICTM

Prof. Shukla:

- **Strengthen land surface observations** by enhancing networks of rain gauges, soil moisture sensors, and related instrumentation.
- **Promote cross-border data sharing** by urging governments to enable open access to critical meteorological and hydrological datasets.
- **Conduct joint training programs** in geopolitically neutral venues to ensure inclusive capacity building across regions.
- **Organize event-based model intercomparisons** to improve understanding and skill of predictions.

Prof. Bin Wang:

- **Encourage the use of AI-based approaches** for model development and data analysis to enhance process understanding and forecasting capabilities.
- **Prioritize the expansion of radar and radiosonde networks** to improve observation of mesoscale and vertical atmospheric structures.
- **Facilitate regional institutional collaboration** to support joint field campaigns, data sharing, and co-development of tools and models.
- **Promote theoretical studies to enhance understanding of monsoon climate variability and future changes.**

Dr. R. Krishnan:

- **Organize Coordinated Model Intercomparison Projects** focusing on a set of Compound Hydrological Extreme Events in the Asian monsoon region (e.g., 2022, 2010 and others).
- **Use model intercomparisons to evaluate the fidelity of current Earth System Models (ESMs)** in capturing compound extreme events and the multi-scale physical processes driving them.
- **Leverage insights from these intercomparisons to improve prediction of extreme events** over the tropics and monsoon regions, thereby strengthening early warning systems and multi-hazard impact forecasting.

Closing remarks

Dr. Thara Prabhakaran closed the session by thanking the panelists and reaffirming ICTM's commitment to advancing collaborative research in tropical meteorology. A detailed summary and actionable recommendations will be shared with ICTM leadership and participating institutions.

YouTube link:
https://www.youtube.com/live/oP_hgM6PI0Y?si=fk2FpxXe_VSGhvpR