NEWSLETTER

Early Career Researchers' Hub for Earth Sciences

ज्ञानाय संगच्छध्वम्

Learn. Contribute.. Grow

Launch Alert!

Introducing the **ECR Hub**—your go-to platform for early-career climate researchers. Built on the idea, **"Learn, contribute, and grow—together.".** Seeded at IITM, expanded across MoES and beyond, this Hub is a space to connect, collaborate, and grow together..

Goal:

To create an "Open Science Hub" within the ECR community with the following objectives:

•Facilitate a structured platform for skill exchange within ECR

•Seminars by ECRs, for ECRs.

•Meetups over *"chai-and-coffee"* to discuss emerging topics in Earth System Science.

Let us all embark on this shared journey—from learners to mentors

Get Involved

Interested in joining the ECR Hub? We'd love to hear from you — tell us what you bring to the table!

To become a part of the ECR Hub, simply scan.

Once registered, you'll receive a confirmation email with details on how to sign up for Hub membership and get involved in ongoing activities.

From the Secretary's Desk

I am delighted to introduce the Early Career Researchers' Hub for Earth Sciences — a dynamic platform dedicated to empowering the next generation of scientists as they confront our planet's most pressing challenges. This initiative reflects our steadfast belief that the future of our nation and our world depends on a vibrant, inspired, and well-supported scientific community. To all ECRs: your curiosity, passion, and innovative spirit are the driving forces behind creating a more resilient and sustainable future. May this Hub provide a rich source of connection, growth, and discovery as you progress along your scientific journeys. I wish you every success as you lead the way toward a brighter future.

Dr. M. Ravichandran

https://ecrhub.github.io/

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NEWSLETTER

Learn, Contribute & Grow

a. Quarterly Seminar Series

- Knowledge sessions through webinars and in-person interactions.
- Thematic sessions (e.g., Monsoon Variability, Prediction, Projections, AI, Forecast applications, etc.).
- Joint sessions with national and international ECR networks.

b. Newsletter (Quarterly)

- Featuring recent publications, modelling tips, datasets, and tools.
- ECR interviews, lab highlights, job/funding opportunities.
- Special "Do You Know?" column on recent breakthroughs.

c. Meteorology Club/Climate Café

- Informal, interactive sessions to discuss real-time weather/climate events.
- Discussion on observational networks, forecast challenges, verification methods, and model behavior.
- Discuss challenges faced on an individual level.

d. Hands-on Training Workshops

- Special focus on open-source tools and reproducible pipelines (GitHub, SVN, spack, Anaconda, Python etc.).
- Tutorials on emerging data formats (e.g., Zarr, Cloud-optimized NetCDF).
- Git-based repositories for community-built code.

Team

- Volunteers
- Working Groups:
  - Training & Workshops
  - Newsletter & Communication
  - Data & Tools
  - Outreach & Collaboration

Director's Message

It is a proud moment for IITM to host the Early Career Researchers' Hub — a platform dedicated to nurturing young talent in Earth sciences.

Early career researchers bring fresh ideas and energy essential to advancing our understanding of the Earth system.

This Hub is designed to foster collaboration across disciplines, institutions, and domains, creating a vibrant space for knowledge exchange, innovation, and growth. We are committed to making it a supportive ecosystem where dialogue and discovery thrive.

Wishing all early-career researchers a rewarding and collaborative journey ahead.

Dr. Suryachandra A. Rao

Our upcoming activities

- Upcoming Seminar: A 'round-the-world' journey through Marine Science: my path as an Early Career Researcher

Presenter: Rita M. Franco-Santos

Affiliation: The University of Western Australia

- Upcoming Events:

Ice-breaker event on 22 Aug 2025

- Upcoming Newsletter:

July-September 2025 Edition

- Upcoming Technical workshop:

Building Portfolio Website 29 Aug 2025

ज्ञानाय संवर्द्धनम्

NEWSLETTER

Research Highlights

Improvements in the prediction of extreme rainfall events with nested high-resolution rapid refresh modelling system over the Indian Himalayan region.

This study highlights the importance of a high-resolution weather model known as High Resolution Rapid Refresh (HRRR) over the Indian Himalayan region helps in predicting high-impact, short-lived, highly-localized extreme rainfall. The HRRR model was configured with two nested domains at 5 km and 1 km resolutions, and hourly assimilation of conventional and non-conventional observations. Three episodes of heavy rainfall events from July–August 2023 were analyzed. The 1 km domain outperformed the 5 km domain in capturing the location and intensity of rainfall, with a better representation of the dynamic and thermodynamic structure of the convective environment. The key takeaway is that higher resolution and hourly data assimilation significantly improve forecasts for localized heavy rainfall over complex terrain like the Himalayas. Read More: https://doi.org/10.1016/j.atmosres.2025.108191

Dr.B R R Hari Prasad Kottu, NCMRWF

Enhancing Indian Ocean Forecasts through Sea Level Data Assimilation

This work presents advancements in the Regional Analysis of Indian OceaN (RAIN) system — a data assimilation framework designed to improve forecasts of ocean conditions in the Indian Ocean. The RAIN system blends satellite and in-situ observations with the Regional Ocean Modeling System (ROMS) using the Local Ensemble Transform Kalman Filter (LETKF) technique. In this study, the system was upgraded to include satellite-derived Sea Level Anomaly (SLA) data, which reflects dynamic changes in sea surface height due to factors such as ocean currents, eddies, and other mesoscale features. Incorporating SLA data is technically challenging, as satellite observations include steric effects (due to temperature and salinity), while the model does not. To address this, a steric correction was applied to the observed SLA, ensuring consistency with the model's framework. Read More: https://doi.org/10.1007/s12040-025-02587-1

Mr. Balaji Badurui, INCOIS

NEWSLETTER

Research Highlights

Assessing the simulation of observed cloud-extreme rainfall relationship in GFS T1534.

The key findings of this study are:

- Systematic Underestimation of Extreme Rainfall Thresholds.
- Degradation of the simulation of Cloud optical property with Lead Time.
- Over-reliance on Cloud Liquid Water to create extreme rainfall.
- Poor Simulation of Atmospheric Heating Profiles.

Overproduction of Deep Convective Clouds Without Corresponding Rainfall.

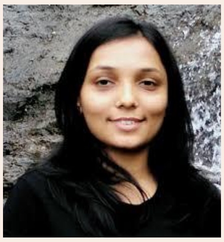
Moreover, this study demonstrates existing limitations in a high-resolution global model (GFS T1534) for short and medium-range prediction at IITM. It also highlights the urgent need to improve convective parameterization to enhance the reliability of short and medium-range forecasts of extreme rainfall. Read More: https://doi.org/10.1175/WAF-D-24-0010.1

Mr.Tanmoy Goswami, IITM

Bridging climate science, policy, and communities: Collaborative pathways for climate resilience in the Indo-Pacific

This publication builds on an international webinar hosted by the IITM Hub in 2023 and reflects a series of regional conversations since. The Indo-Pacific region faces a complex mix of climate risks—from sea-level rise and heatwaves to melting glaciers and dwindling freshwater availability—that disproportionately affect vulnerable communities. At the same time, efforts to respond are often fragmented, top-down, or disconnected from local needs. This paper addresses this gap and highlights that climate information, to be actionable, must be embedded within local contexts through co-production and inclusive dialogue.

Read More: https://doi.org/10.3389/fclim.2025.1538123



Dr. Aditi Modi, IITM

Research Highlights

Vertical structure of mesoscale eddies and their impact on the modulation of tracer fields in the eastern Arabian Sea

The present study utilises a combination of observation and ocean reanalysis data to comprehend the vertical structure of mesoscale eddies and their influence on the modulation of tracer properties (temperature, salinity, and chlorophyll) in the Eastern Arabian Sea (EAS). Mesoscale eddies in the EAS are surface intensified, with the geostrophic velocity concentrated in the upper 100 m and with a surface thermohaline anomaly core in general. This study highlights include Spatial and seasonal variation in the composite eddy structure, with the eddy core being shallower in the south and stronger in winter/spring, Eddy polarity influences the depth of subsurface salinity maximum and subsurface chlorophyll maximum. Mesoscale eddies induce sufficiently strong intraseasonal variability.

Ms. Midhila V, INCOIS   Dr. Jithin, NIO

Impact of Wind Forcing in a Nested Indian Ocean Regional Model

Bulk formulas are used to estimate the turbulent surface fluxes (heat and momentum) over global oceans for weather forecasting, climate models, and ocean models. These formulas parameterize turbulent fluxes using near-surface atmosphere and ocean state variables. This turbulent flux computation introduces significant errors due to the errors in input meteorological variables used in bulk algorithms, apart from the algorithm types. Stand-alone forced ocean models also use near-surface atmospheric variables from reanalysis or corrected reanalysis products. SST is influenced by air-sea flux exchange and mostly by net heat flux over the north Indian Ocean. Accurate computation of turbulent flux is needed to capture the realistic seasonal, intra-seasonal, and inter-annual SST variations in ocean model simulations. This study evaluates the impact of near-surface wind forcing in SST and current simulation in a nested regional Indian Ocean model. These simulations were evaluated using in situ and satellite observations. The results show significant improvements in temperature and surface current simulations with QuikSCAT forcing compared to CORE-II forcing.

Ms Raheema Rahaman, INCOIS-KUFOS

Research Highlights

Modeling ocean diurnal cycle and its scale interaction to climatic Variabilities

Climate models have evolved a lot; However, they still have few problems, which include:

- They don't fully capture how the ocean and atmosphere change during the day.
- They struggle to represent changes that happen over weeks to months (like monsoon intra-seasonal patterns).
- They often get seasonal rainfall and ocean-atmosphere interactions wrong.

The key idea is to better include the daily (diurnal) changes in the top layer of the ocean — known as ocean skin temperature. By adding a method to represent this temperature change more accurately and using a better way to estimate air-sea energy exchanges, the model becomes more realistic. The results show that when these daily changes are modeled well, it also helps improve predictions over longer periods — like weeks, months, or seasons. This is especially useful for improving forecasts during the Indian summer monsoon. Read More: https://or.niscpr.res.in/index.php/IJMS/issue/view/383

Dr. Maheswar Pradhan, IITM

Bridging the Gap between Weather and Climate: From Local Phenomena to Global Change

I participated in the CLIVAR Climate Dynamics Panel 5th Annual Workshop at Melbourne, Australia, from 24-27 Feb 2025. The deliberations of the Workshop were published in the CMIP blogs, which can be summarized as follows: The coarse resolution of current GCMs limits their ability to bridge the gap between weather and climate, especially at regional scales. However, this challenge can be addressed by identifying causal pathways between small-scale weather processes and large-scale climate through km-scale simulations, improved parameterizations, and analysis of scale interactions. The modeling community is encouraged to:

Develop parameterizations informed by high-resolution models, exercise caution in interpreting regional projections, and rigorously assess scale interactions to reduce uncertainty. Read More: https://wcrp-cmip.org/bridging-the-gap-between-weather-and-climate-from-local-phenomena-to-global-change/

Dr. Ankur Srivastava, IITM

Research Highlights

Melting Arctic sea ice enhances intense summer monsoon rainfall events in South Asia in a warming climate.

Arctic sea-ice decline has been accelerating in response to greenhouse warming. In this study, we use observational data and simulations from the IITM Earth System Model (IITM-ESM) to examine the influence of Arctic sea-ice loss on tropical precipitation, with a particular focus on intense summer monsoon events over South Asia. The enhanced Arctic sea-ice melt increases the mid-latitude waviness and intensifies the circumglobal teleconnection-like pattern and strengthens the subtropical high over East Asia. This, together with a La-Nina like response in the Pacific enhances mean summer monsoon precipitation over South Asia. Additionally, the enhanced energy in the tropics and the anomalous mid-latitude intrusions due to the Arctic sea-ice melt provide a conducive environment for moisture convergence and intense summer monsoon precipitation events over South Asia. Read More: https://iopscience.iop.org/article/10.1088/1748-9326/add0ca

Dr. Sandeep Narayanasetti, IITM

Subseasonal Prediction of the 2022 Indian Monsoon in Real Time: Focus on East–West Rainfall Disparity

This study assesses the real-time performance of a multi-physics multi-ensemble (MPME) subseasonal prediction system during the 2022 Indian summer monsoon. Despite overall above-normal rainfall, eastern India, particularly the Indo-Gangetic plains, experienced deficits. The MPME system effectively captured key features such as weak June rainfall and a strong east–west rainfall asymmetry in July–August. Extra-tropical influences, including West and East Asian blocking ridges, were linked to this asymmetry. The model demonstrated skill in forecasting active and break spells 2–3 weeks ahead, with improved monsoon ISO prediction in 2022. However, skill declined beyond two weeks over smaller spatial domains. Read More: https://doi.org/10.1007/s00382-025-07700-0

Dr. Avijit Dey, IITM

Research Highlights

Assessment of ocean wave energy potential and identification of technologically feasible hotspots for Indian coastal regions

An assessment of the wave energy potential in the exclusive economic zone (EEZ) of India using high-resolution daily climatology data (1993–2022) generated by the WAVEWATCH III model. This analysis is confined to the regions ranging from 0 to 150 m water depth, encompassing onshore (0–25 m), nearshore (25–75 m), and offshore (75–150 m) zones, where the wave energy converters (WECs) with the present technology can be deployed and operated. The identification of hotspots along coastal states, which have a year-round temporally consistent energy inflow within the feasible operational range of WECs, is achieved using a combination of a novel metric, consistency percentage, and the cumulative annual available wave power density. The cumulative annual extractable wave energy from these hotspots is evaluated through a case study using two different WEC technologies. Read More: https://doi.org/10.1007/s40722-025-00407-8

Mithun Sundhar B, INCOIS

A Machine Learning approach to identify upper ocean water masses in the Indian Ocean

The spatial and temporal variability of the ocean drives its mixing, which in turn drives the ocean heat uptake and circulation. Determining Indian Ocean (IO) spatial structures has relied on combinations of its physical, chemical, and dynamic properties. In this study, we apply an unsupervised classification technique (Gaussian Mixture Modelling (GMM)) to Indian Ocean Argo float temperature and salinity profiles as a step toward an alternative method for defining spatial variations. GMM automatically distinguishes many spatially coherent groups influenced by temperature and low/high salinity water masses without using any spatial position (latitude or longitude) detail. GMM can be used to classify constructs in both observational and model data sets because it is stable, systematic, and automatic, making it a valuable supplement to existing classification techniques.. This is noteworthy because the climate science and ocean sciences communities need a new generation of methods, including the machine learning techniques described in this work.

Dr. Shikha Singh, IITM

Do you know?

EarthCARE Satellite – An Eye on Clouds, Aerosols & Radiation

EarthCARE (Earth Clouds, Aerosols and Radiation Explorer) is a flagship joint satellite mission between the European Space Agency (ESA) and Japan Aerospace Exploration Agency (JAXA), launched in May 2024. Its primary goal is to improve our understanding of the role clouds and aerosols play in Earth's radiation budget—a key uncertainty in climate predictions. The scientific objectives of the mission are: To observe vertical profiles of natural and anthropogenic aerosols on a global scale, their radiative properties and interaction with clouds, To observe vertical distributions of atmospheric liquid water and ice on a global scale, their transport by clouds and their radiative impact, To observe cloud distribution, cloud-precipitation interactions and the characteristics of vertical motions within clouds. For further information on instruments, data availability, and tools please visit the EarthCARE - Earth Online.

Rapid Evaluation Framework (REF)

The CMIP7 Rapid Evaluation Framework (REF) is a modular, community-driven system designed to provide fast, transparent, and objective assessments of Earth System Models as part of the CMIP7 cycle. Its goal is to integrate automated diagnostics directly into the ESGF infrastructure, allowing model evaluation results to be published alongside the data. Built using containerized tools and APIs, REF enables reproducible, scalable workflows and supports early identification of model strengths and weaknesses. Developed through community consultation, it aims to support the IPCC AR7 timeline and encourages participation from modelling centres, ESGF nodes, and researchers across the WCRP community.

Toward Exascale Climate Modeling: Lessons from ICON

A recent study by German Climate Computing Centre explores which computer hardware (types of processors) works best for running ICON efficiently at a high-resolution (1.2 Km) global simulations that can capture small-scale processes more accurately, and what software changes are needed to make it compatible with such systems. Tests on different computer architectures show that splitting the model into smaller parts (parallelization by domain or domain decomposition) has reached its limits. Now, the speed and efficiency of individual nodes (computing units) are more important. The analysis also finds that faster memory access is more useful for ICON than just having high computational power.

Do you know?

This article reveals important lessons for the broader modeling community:
a. Scalability Limits: Traditional parallelization methods—especially domain decomposition—are approaching their limits. Future performance gains must increasingly come from optimizing single-node efficiency rather than simply increasing the number of cores.
b. Hardware-Aware Optimization: Models must be tuned not only for computational power but also for memory bandwidth and data movement, which often become the bottlenecks at high resolution. Architectures with high memory throughput are often more effective than those focused purely on peak FLOPs.
c. Software Re-Engineering: To adapt to heterogeneous and evolving hardware platforms, model codebases must transition from monolithic to modular, flexible designs. This enables easier adaptation to diverse architectures (CPUs, GPUs, AI accelerators) and supports emerging parallel programming models.
d. Energy Efficiency Matters: As computational demands grow, so does the importance of energy-aware computing. Efficient use of node-level resources contributes not only to performance but also to sustainability.
In short, unlocking the potential of exascale computing for Earth system modeling requires a co-design approach—aligning model architecture, hardware capabilities, and software design. These insights are broadly applicable across next-generation weather, ocean, and climate modeling systems aiming for both scientific accuracy and computational efficiency.

WP-MIP: Weather Prediction-Model Intercomparison Project

WP-MIP represents a major step from WCRP-ESMO towards an integrated development, integration and evaluation of AI, physics-based, and hybrid forecasting methods, analyzing not just accuracy but also physical validity, model stability, and extreme event handling. By encouraging interoperability and standardized diagnostics, it equips the weather modeling community with a robust platform to advance next-generation predictive systems. The project has the following objectives
a. Compare forecasting paradigms: Bring together AI-based (AIWP), physics-based (NWP), and hybrid weather models under a unified intercomparison framework.
b. Build a public forecast archive: Provide a centralized repository for global medium-range forecasts (hindcasts for 2024) to assess strengths, weaknesses, and biases of various models.
To know more and participate in WP-MIP, please visit WP-MIP: the Weather Prediction Model Intercomparison Project — ESMO Website.

Community Ethos

We uphold the values of mutual respect, constructive dialogue, and equitable knowledge sharing across the ECR community.