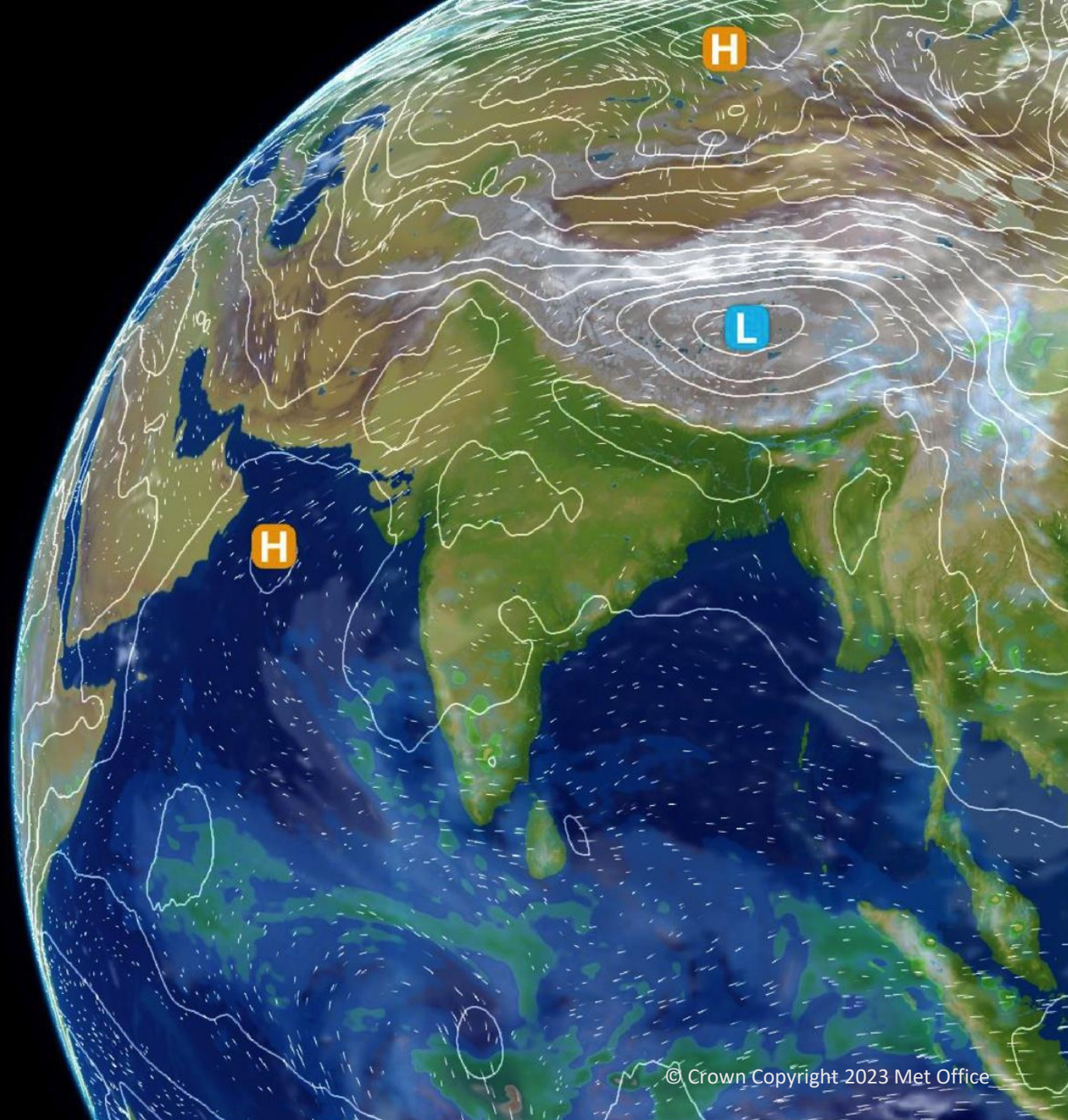
Delivering the Weather and Climate Science for Service Partnership (WCSSP) India in collaboration

Dr Huw Lewis *(Met Office, UK)*

On behalf WCSSP India Project team



IWM-8, Pune, 17 March 2025; Oral-9 (Theme-3/OT-3)

www.metoffice.gov.uk

WCSSP India Project Overview

WCSSP India is focussed on enhanced understanding, methods, and tools for improving risk-based forecasting of natural hazards.

These outputs provide a pathway for partners in the Indian Ministry of Earth Sciences (MoES) to deliver improved weather and seasonal climate services.

UK and India 2030
Government Strategic Roadmap

WCSSP India Project Activities, Outputs, Outcomes

Met Office

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We deliver through …

Project Activities

- Research from **global to regional to urban scales** for hazard prediction
- Develop and evaluate **coupled model ensemble simulation frameworks**
- Optimise **observation use for model initialisation** through assimilation
- Joint **inter-comparison and sensitivity studies** to understand systematic biases
- Make and use research observations **to enhance process understanding**
- Enhance **impact-based forecasting** methods to assess risk across scales
- Explore the value of **data science and ML methods** across the forecasting chain
- Share knowledge through regular **peer and cross-project interactions**
- **Communicate our research** to raise awareness and encourage user uptake

Which directly lead to …

Project Outputs

- **Improved understanding** of the processes that drive extreme weather and their impacts
- **Strengthened scientific, technical and modelling capabilities** across all partners
- New research enabling the **co-development of prototype tools**
- Strengthened **partnerships, networks and knowledge exchange** between UK and India
- Publishing open access **joint UK-India research papers** in internationally recognised journals

In the longer term this enables …

Project Outcomes

- **Enhanced capacity of MoES** to develop, implement and routinely support improved operational weather and seasonal climate services
- New services and products developed by MoES used to **provide improved impact-based predictions of high impact weather and multi-hazard events** across timescales
- **Mature, long lasting and equitable partnerships** amongst UK and India science and services community, delivering mutual benefit
- Leveraged opportunities for joint research with other relevant initiatives in the UK and India, **capitalising and adding value** to existing investment

Which contributes to …

Project Impacts

- Public, Governments and Industry around the world use **more accurate weather forecasts** to make better decisions, stay safe and thrive
- **Improved resilience** to prepare for the effects of extreme weather and seasonal extremes in India, the UK and globally
- Supporting the realisation of the **Sustainable Development Goals**
- International policies and strategies are **informed by state-of-the-art science**

WCSSP India Project Scope

Met Office

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- High-resolution global coupled ensemble
- Convective-scale coupled modelling
- Next generation sub-km scale modelling
- Improving models using satellite data

WP1: Developing seamless ensemble coupled systems across scales

- Coupled model evaluation and inter-comparisons
- Understanding model error evolution, physical processes, scale interactions
- Evaluation of sea ice and Southern Ocean processes

WP2: Evaluation and understanding of monsoon processes and hazards

Understanding model biases; new diagnostics & parameterisations

Exploiting new coupled capabilities for multi-scale research

Sub-km modelling studies; novel diagnostics

New DA methods for exploiting observations

'End-to-end' forecasting

Enhanced observations for evaluation

Predictability of extreme weather; seamless verification

Understanding of underpinning predictive skill for risk-based forecasting

Broad-scale context for hazard processes

Value of new capabilities for IBF

WP3: Observing the environment to improve predictions

Impact-relevant events, demonstrate value of observations

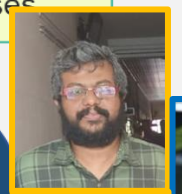
Observations underpinning forecasts for decision-making

WP4: Risk based forecasting of high impact weather events

- Process-based observations to underpin physical understanding
- Evaluate new developments in atmosphere model parametrisations

- Predictability, post-processing, verification of high impac
- Impact modelling and forecasting techniques
- Translating forecasts for improved decision-making





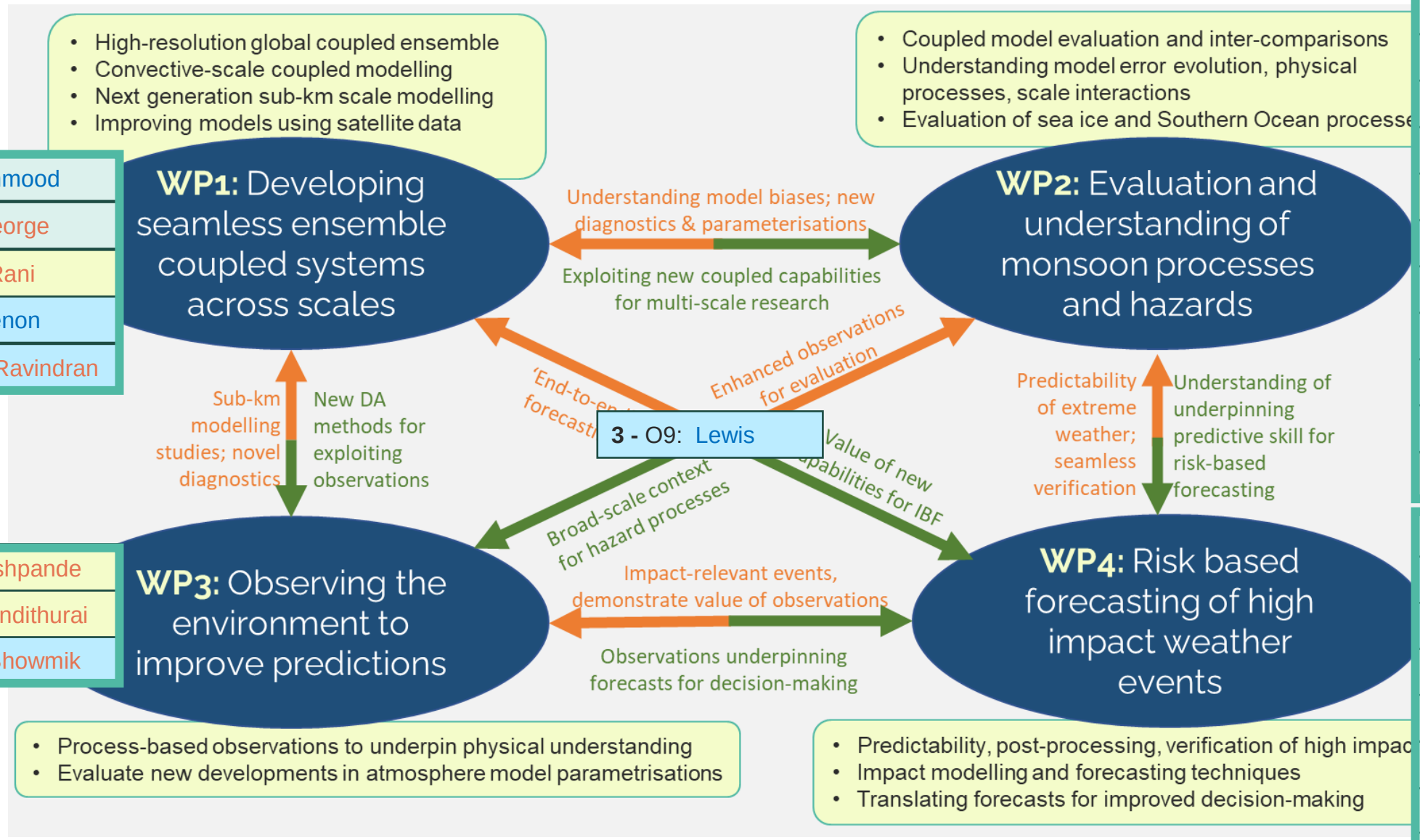






- [WCSSP India Science Plan]

WCSSP India at IWM-8



1 - O5: Mahmood
1 - IT17: George
2 - PTh21: Rani
3 - O10: Menon
3 - PTu45: Ravindran

2 - O14: Deshpande
2 – IT10: Pandithurai
3 - PTu30: Bhowmik

1 - O3: Deoras
1 - O20: Volonte
1 - O24: Srivastava
1 - PM7: Deoras
1 - PM31: Turner
1 - PM33: Mukherjee
2 - PTh8: Pillai
3 - IT5: Martin
3 - PW9: Deoras
3 - PW18: Keane
3 - PW29: Ellis
3 - PW31: Gautam
4 - IT22: Turner

1 - O31: Widmann
3 - O27: Mittermaier
3 - PW45: Ashrit
5 - IT27: Lumbroso
5 - O47: Jenamani
5 – O48: Kolusu
5 – PF2: Dyson
5 – PF8: Noyes
5 – PF17: Katiyar

Oral schedule Poster schedule

16 talks; 15 posters; cross-WP coverage

WCSSP India Project Activities, Outputs, Outcomes

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We deliver through …

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Improved understanding of the processes that drive extreme weather and their impacts

Research to enhance process understanding and predictions

Met Office

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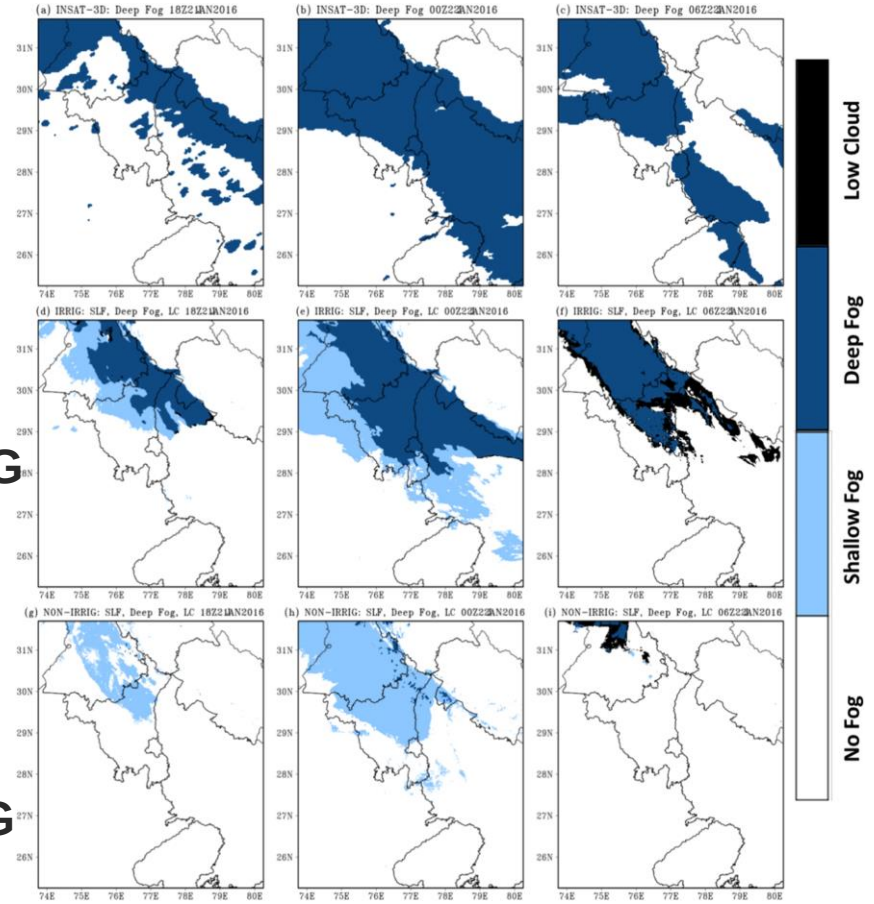
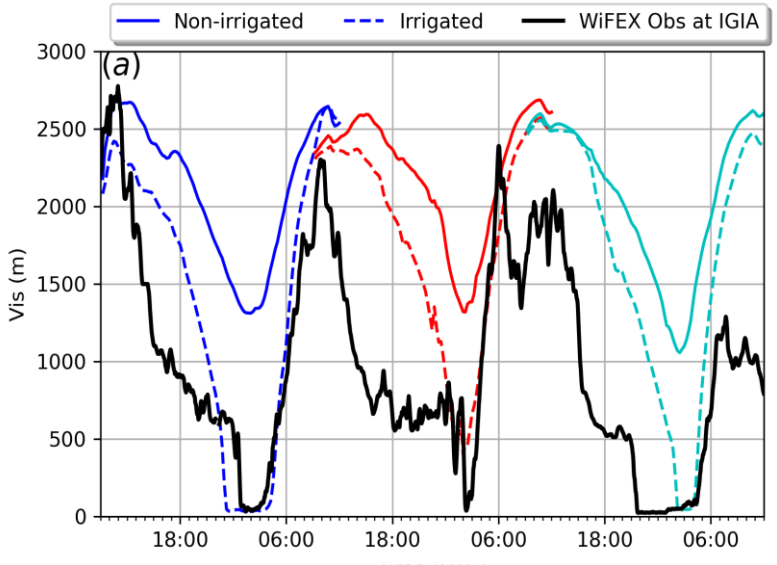
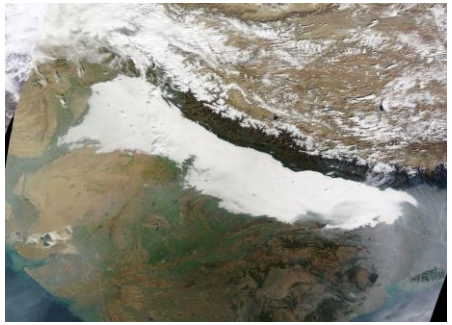
OBS

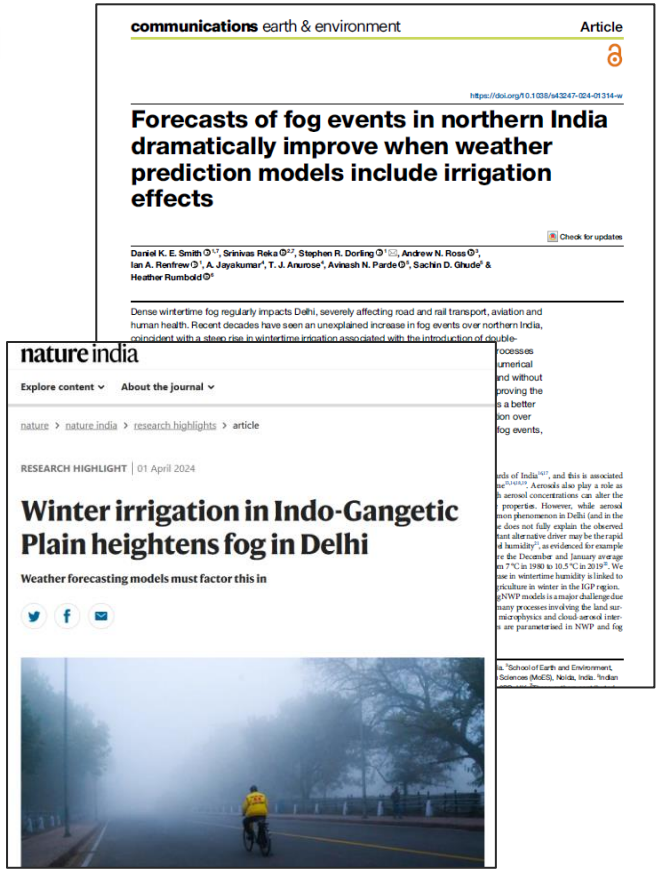
IRRIG

NO-IRRIG









communications earth & environment — Article

https://doi.org/10.1038/s43247-024-01314-w

Forecasts of fog events in northern India dramatically improve when weather prediction models include irrigation effects

Check for updates

Daniel K. E. Smith, Srinivas Reka, Stephen R. Dorling, Andrew N. Rosa, Ian A. Renfrew, A. Jayakumar, T. J. Anurose, Avinash N. Pardeˢ, Sachin D. Ghude & Heather Rumbold

Dense wintertime fog regularly impacts Delhi, severely affecting road and rail transport, aviation and human health. Recent decades have seen an unexplained increase in fog events over northern India, coincident with a steep rise in wintertime irrigation associated with the introduction of double-

nature india

Explore content · About the journal

nature › nature india › research highlights › article

RESEARCH HIGHLIGHT | 01 April 2024

Winter irrigation in Indo-Gangetic Plain heightens fog in Delhi

Weather forecasting models must factor this in

[Smith et al., 2024](), Nature Communications Earth & Environment

UNIVERSITY OF LEEDS

University of East Anglia

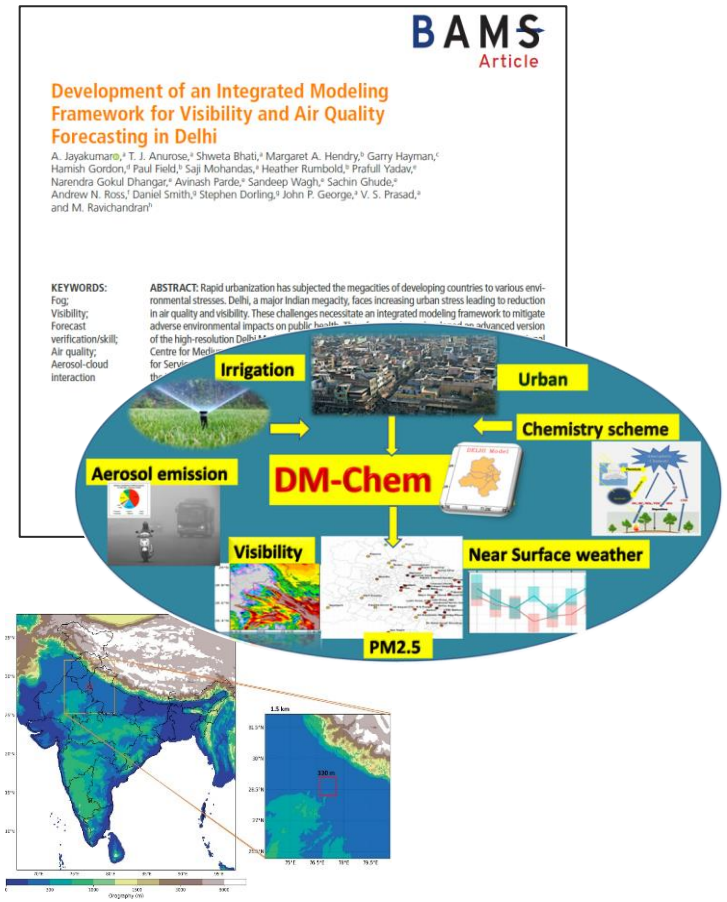
Strengthened scientific, technical and modelling capabilities across all partners

Enhanced modelling capability

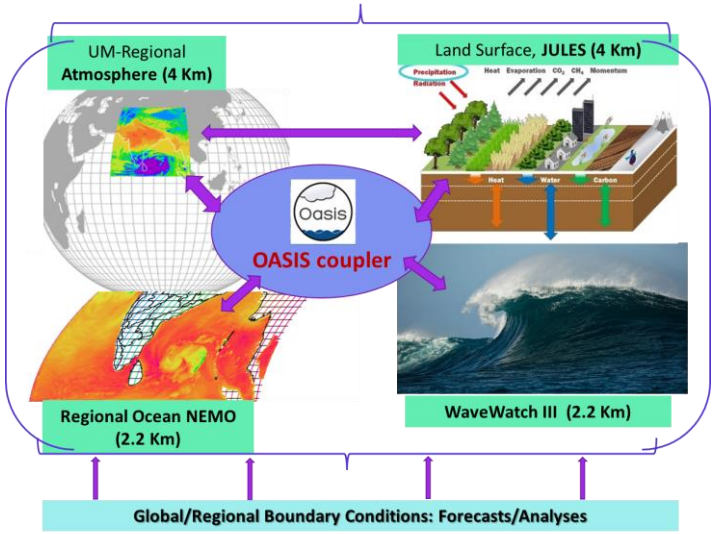
Met Office

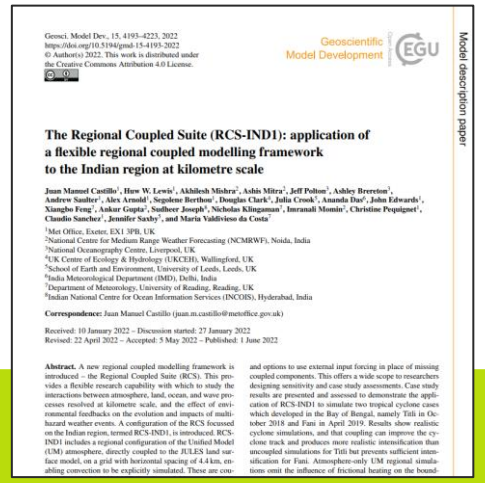
Ministry of Earth Sciences

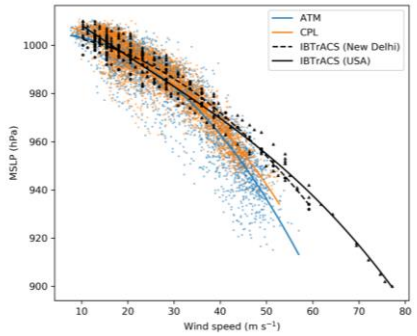
Urban-scale modelling



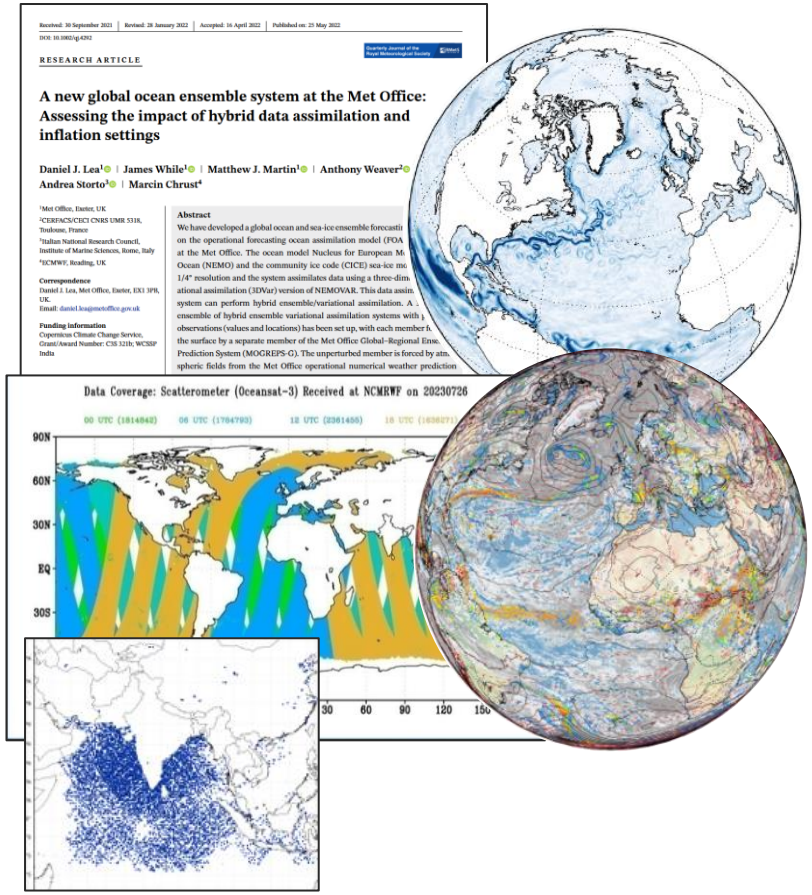
Km-scale regional coupled prediction




The Regional Coupled Suite (RCS-IND1): application of a flexible regional coupled modelling framework to the Indian region at kilometre scale



Global coupled ensembles


A new global ocean ensemble system at the Met Office: Assessing the impact of hybrid data assimilation and inflation settings

Data Coverage: Scatterometer (Oceansat-3) Received at NCMRWF on 20230726

[Jayakumar et al. 2025]

[Castillo et al. 2022]

[Lea et al. 2022]

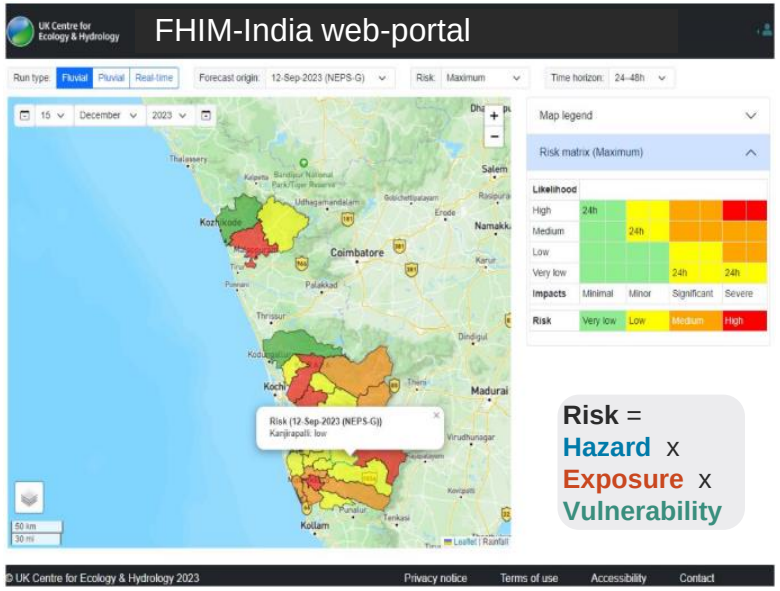
New research enabling the **co-development of prototype tools**

Research to application

Met Office

Ministry of Earth Sciences

Flood Hazard Impact Model



Ensemble-driven sector-specific pluvial and fluvial flood risk forecasts

[10:45 Friday]

UK Centre for Ecology & Hydrology

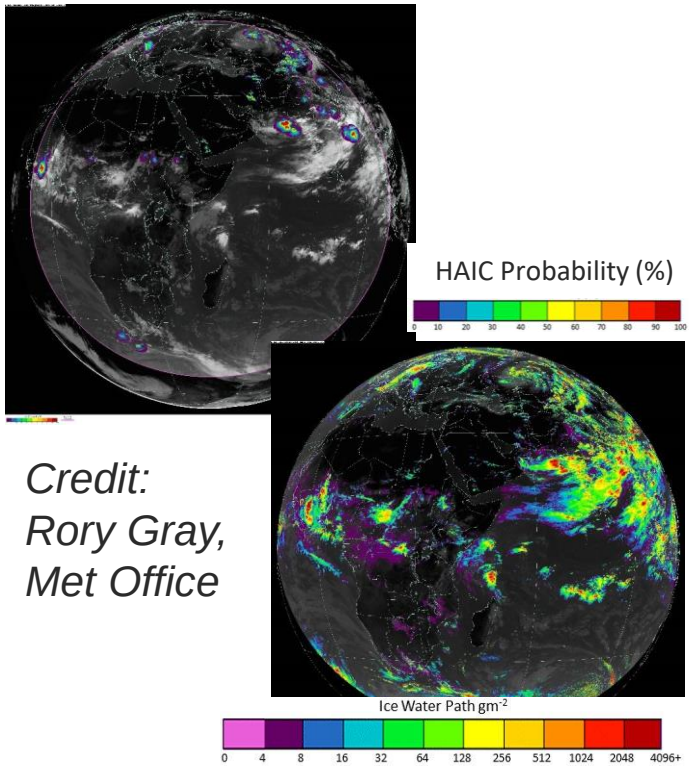
Satellite-based impact and vulnerability assessments

Flooding and windstorm impacts on agriculture

hrwallingford

SIVA: Satellites for Impact & Vulnerability Assessments **Web App**

Satellite-derived severe convection and lightning hazard



Credit: Rory Gray, Met Office

Strengthened **partnerships, networks and knowledge exchange** between UK and India

Ongoing UK academic partner projects

Met Office

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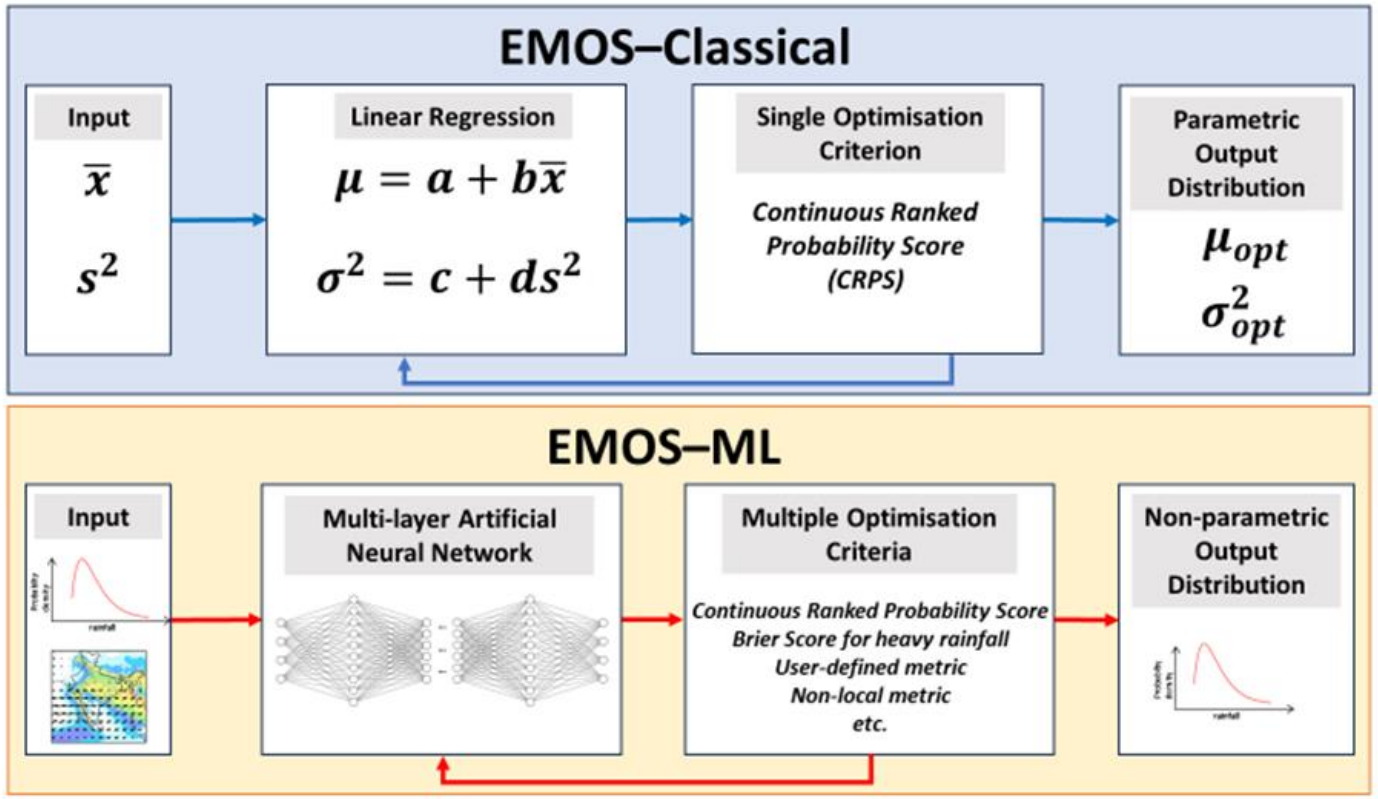
HEavy Precipitation forecast Postprocessing for India with Machine Learning (HEPPI-ML)



- Use Machine Learning for postprocessing daily rainfall ensemble forecasts
- Builds on prior work using statistical postprocessing under exploration for operational implementation
- Builds on Ensemble Model Output Statistics (EMOS) approach with additional predictors, extend optimization and physical interpretation of outputs

Led by University of Birmingham; PI Martin Widman **[12:10 Wednesday]**

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Ongoing UK academic partner projects

Met Office

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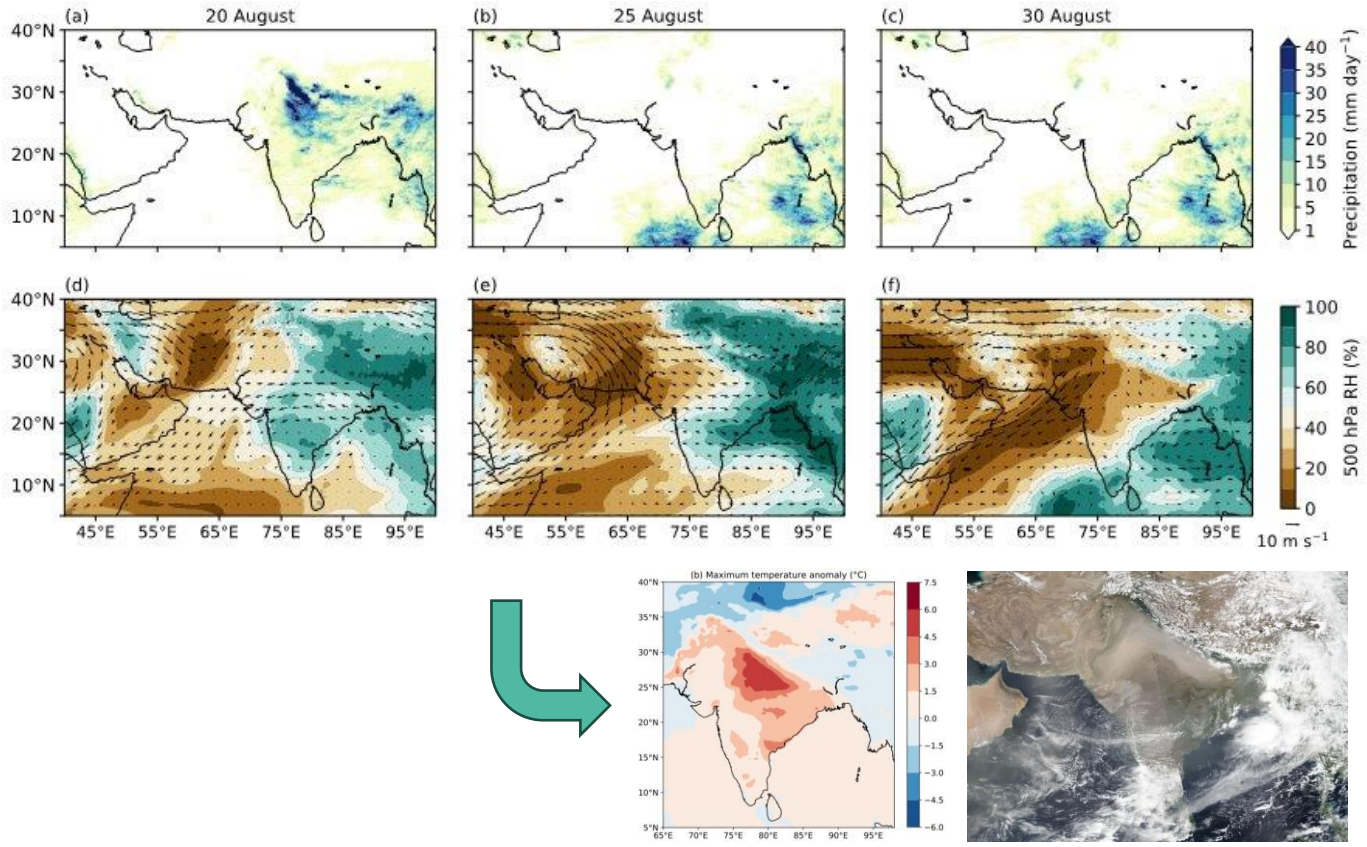
On Understanding The Breaks in Rain, Exacerbating Air Kwality (OUTBREAK)



- Focus on process understanding and predictability of monsoon breaks
- Exploring impacts of monsoon breaks, with focus on heatwaves, dust storms and air quality
- Builds on previous WCSSP India projects spanning from large-scale drivers to local impacts

University of Reading

OUTBREAK

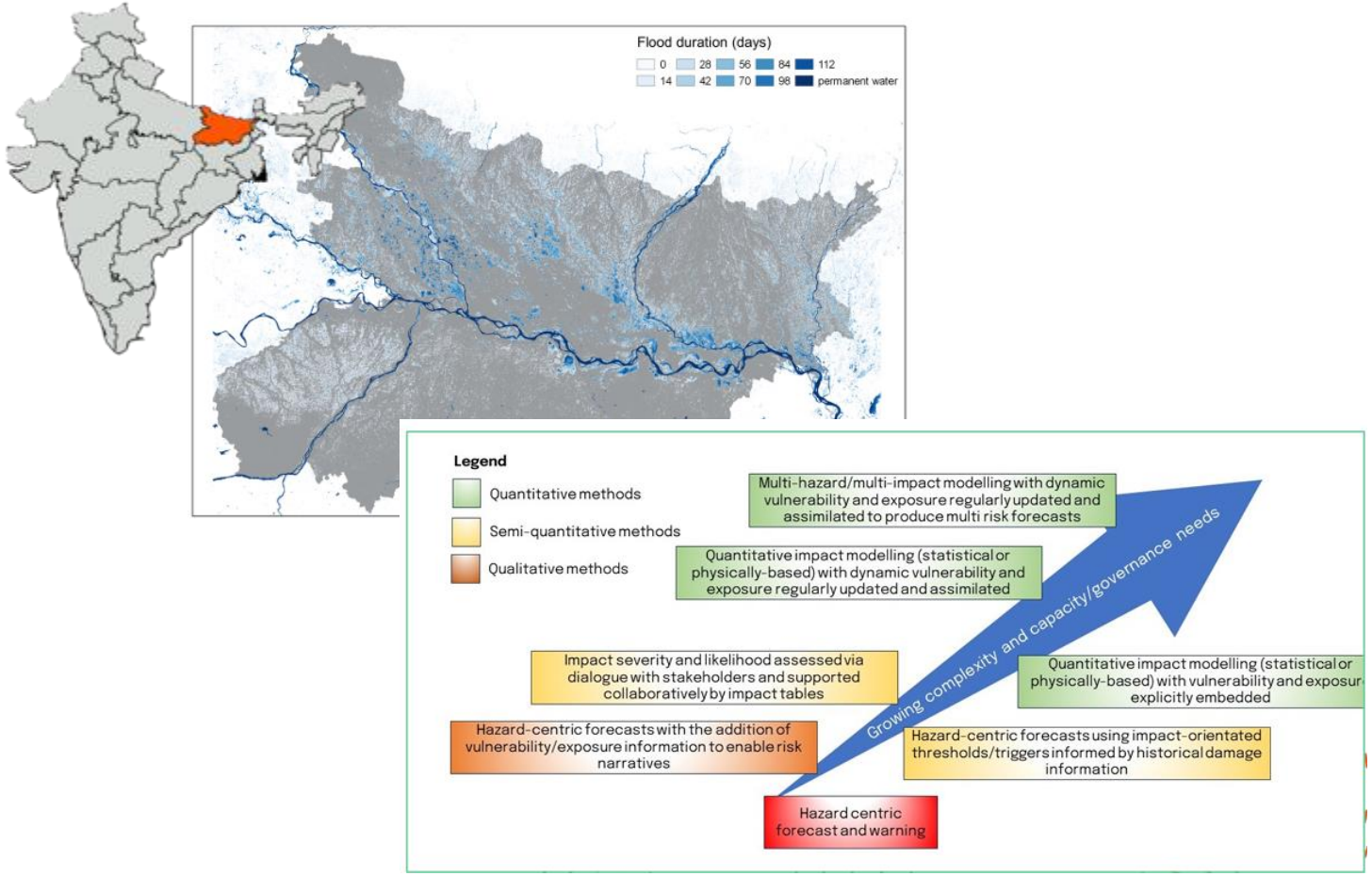
Led by University of Reading; PI Andy Turner **[14:45 Tuesday]**

Ongoing UK academic partner projects

Met Office

Ministry of Earth Sciences

Multi-risk Impact baseD forecASting (MIDAS)



- Focus on improving understanding of scientific and technical requirements for multi-risk assessment
- Aiming to support development of enhanced Impact-based Forecasting
- Approaches to describe interactions between multiple hazards and varying vulnerabilities in time and space

hr wallingford

Led by HR Wallingford; PI Darren Lumbroso **[09:20 Friday]**

WCSSP India Project Activities, Outputs, Outcomes

Met Office

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MoES India academic call now open…

Met Office

सत्यमेव जयते
Ministry of Earth Sciences

Call for Research Proposals under Weather and Climate Science for Service Partnership India (WCSSP-India)

Introduction

Weather and Climate Science for Service Partnership India (WCSSP-India) is a collaborative science initiative between the UK and India, aimed at advancing scientific understanding and modelling capabilities for improved weather and climate services by MoES with a focus on extremes and associated multi-sector impacts. It currently involves the Met Office, UK academic partners, and the Ministry of Earth Sciences (MoES), Govt. of India. Key science objectives of WCSSP-India project include research on natural hazards in South Asian Monsoon system (focus on days to season timescale and global to regional scale drivers); Improve capability of global coupled, regional convective scale coupled and sub-km city-scale modelling frameworks; Observation and process studies, Improve tools and techniques for risk-based forecasting of natural hazards at a range of prediction timescales. WCSSP-India aims to help MoES to deliver services with enhanced local scale forecast skillwith anticipated impacts to the disaster management authorities so as to plan for appropriate emergency response to ensure public safety. To achieve desired goals aimed under WCSSP-India, participation of Indian Universities and other Indian research Institutes are very essential. To attract Indian academia/researchers, it is decided to invite projects proposals under WCSSP-India themes. WCSSP India research is composed of four inter-dependent work packages (WP).

WP1: *Developing seamless coupled ensemble systems across scales*

WP aims: In partnership, develop cutting-edge seamless modelling systems that underpin environmental predictions across space scales and time scales from hours to seasons ahead. Specific aims include development of global coupled ensemble systems, regional coupled ensemble systems and improvements to urban-scale atmosphere modelling.

WP2: *Evaluation and understanding of monsoon processes focusing associated incidence of high frequency and high intensity hazards including anticipation of cascading and compounding imapcts*

WP aims: In partnership, develop novel diagnostic tools and use observations to assess critical processes of monsoon prediction and associated hazards, and carry out process research to understand the predictability and systematic errors of coupled models at seasonal and sub-seasonal timescales.

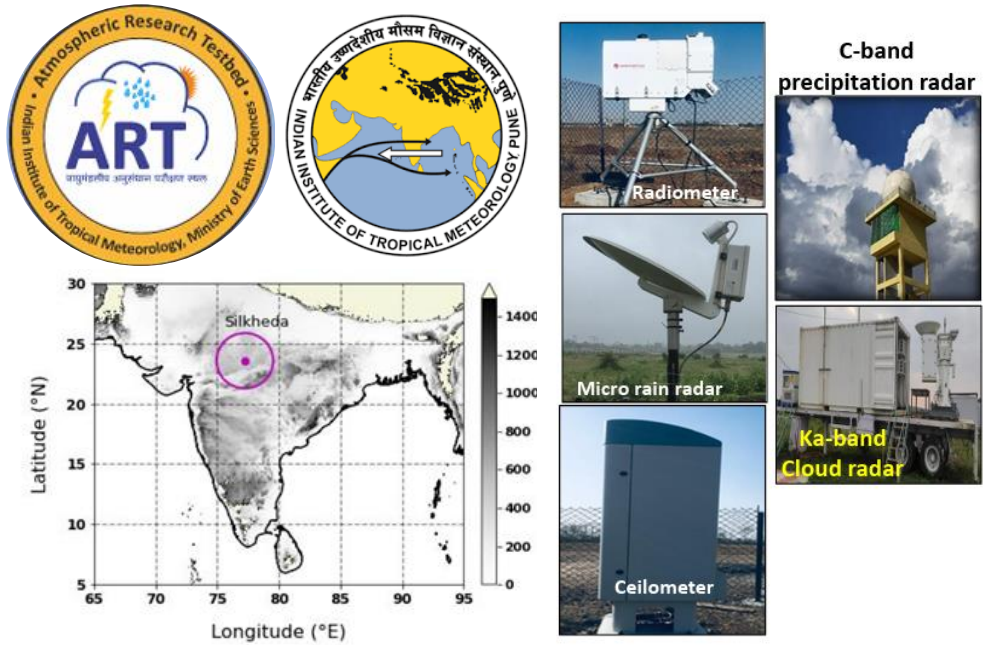
WP3: *Observing the environment fortaking up targeted process studies for improved predictions*

NEWS AND ANNOUNCEMENTS

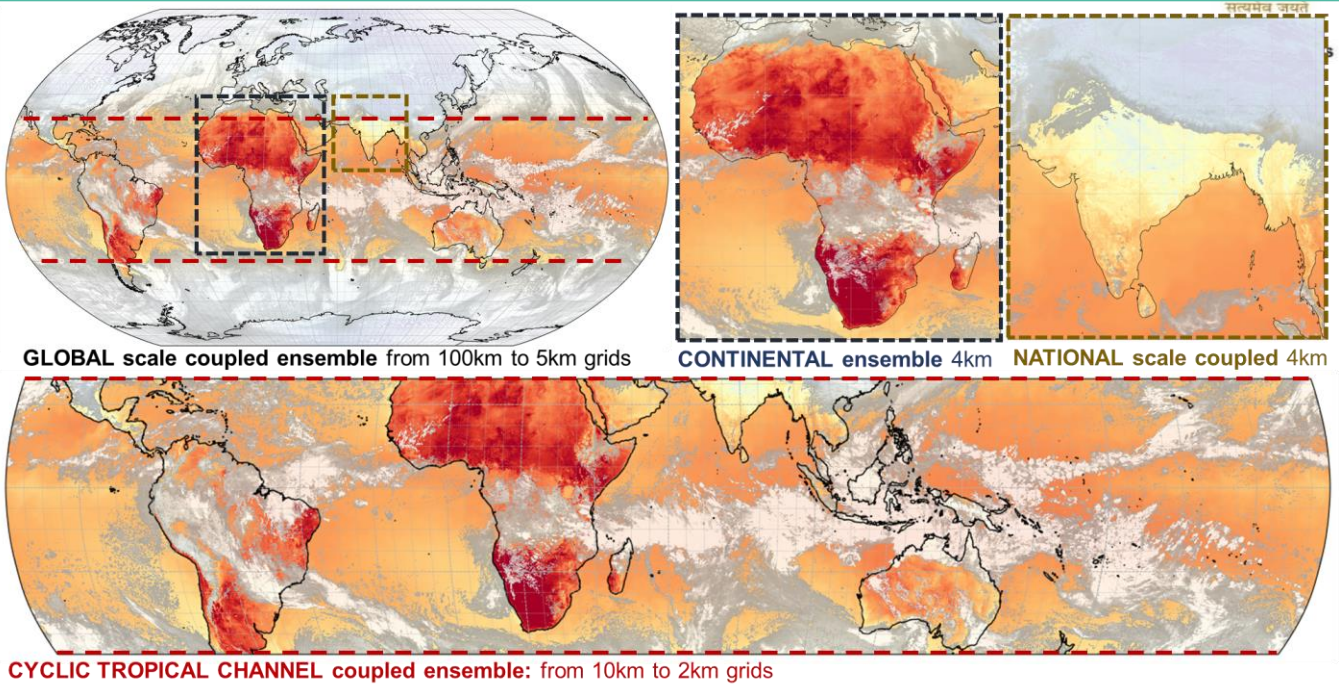
Call for Research Proposals under Weather and Climate Science for Service Partnership India (WCSSP-India)

- **Deadline for applications: 30 April 2025**
- https://moes.gov.in/sites/default/files/2025-03/WCSSP-India.pdf
- *"Project proposals should articulate how they will enhance collaboration with MoES institutions and with UK partners on research and development themes"*

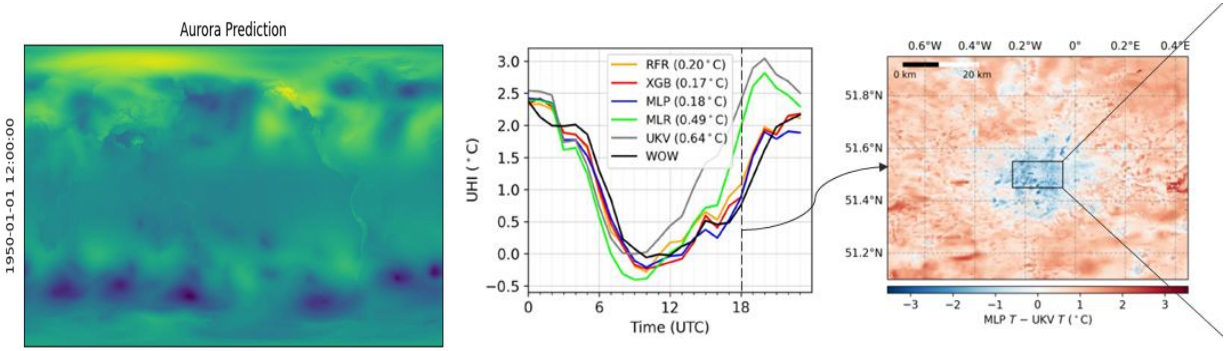
Future directions under WCSSP India…



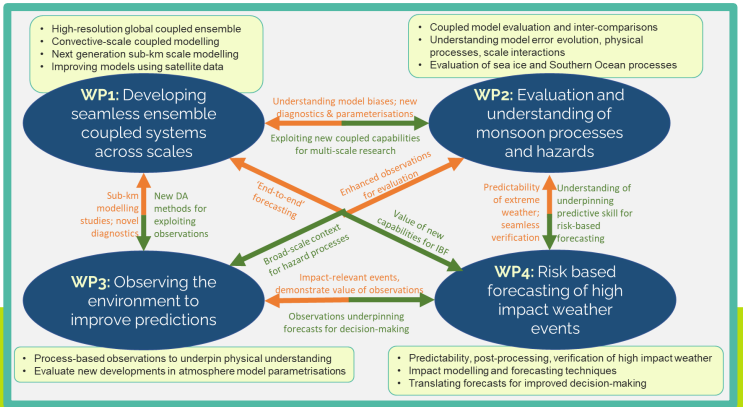
Use world-class research observations for process understanding and model improvement and evaluation



Develop and evaluate new generations of coupled models across scales to enhance process understanding and information to users



Assess the benefits and limitations of machine learning across WCSSP India research themes, and from global to local scales

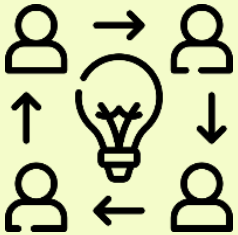


WCSSP India in numbers

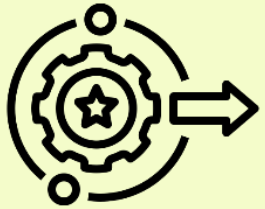
Measurable progress in collaboration

>80 total publications
>600 citations
~40% joint UK/India

5 Annual Workshops
171 registrations 2023
3+6 visiting scientists



7 Working Groups
107 JASMIN users
27 training events



11 new capabilities
9 prototype tools
~30 deliverables/yr

Thank you

Met Office

Ministry of Earth Sciences

Thank you

Dr Huw Lewis (Met Office, UK)
huw.lewis@metoffice.gov.uk