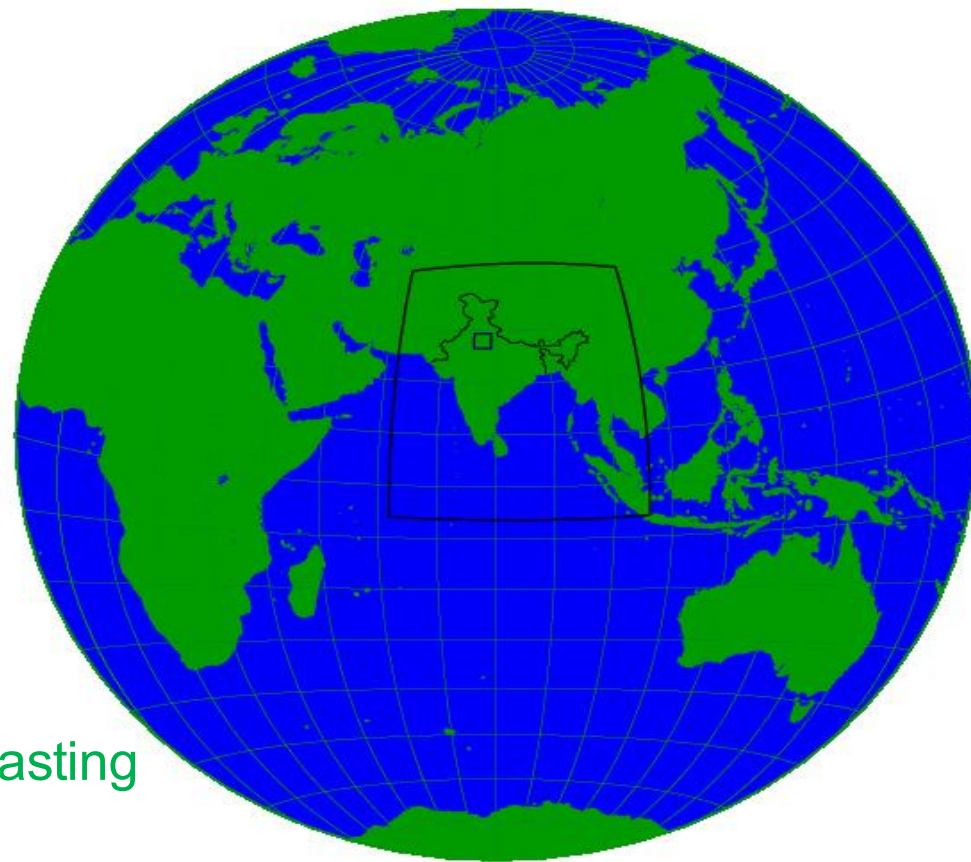




NCMRWF contribution to RIMES



Saji Mohandas

7 May 2025

National Centre for Medium Range Weather Forecasting
Ministry of Earth Sciences

National Centre for Medium Range Weather Forecasting (NCMRWF)

Core Operational Capabilities:

- High Resolution Regional Models for **Short Range NWP**
- Global NWP system for **Medium Range forecast**
- Coupled Forecast System for **S2S forecast** (Coupled Medium-Range forecast system will be operational soon)
- **Data Assimilation** – Atmosphere, Ocean, Sea-Ice & Land Surface
- **Global & Regional Reanalysis** (NGFS & IMDAA Reanalysis)

NCMRWF Mission

“

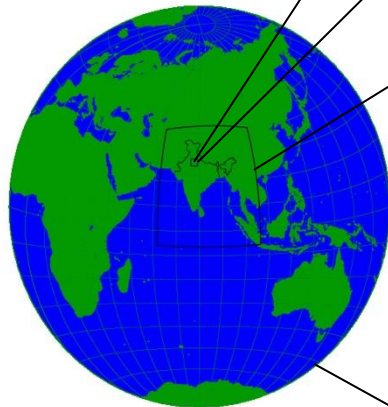
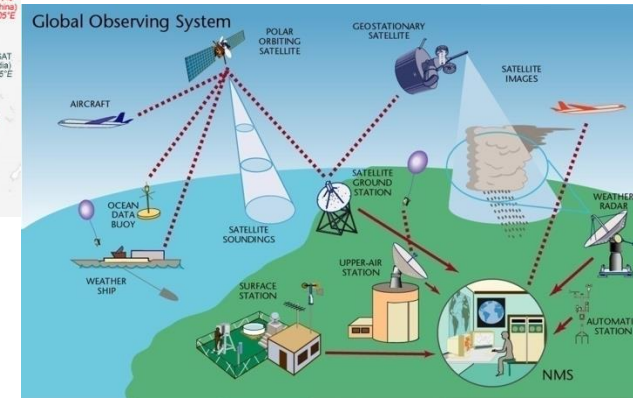
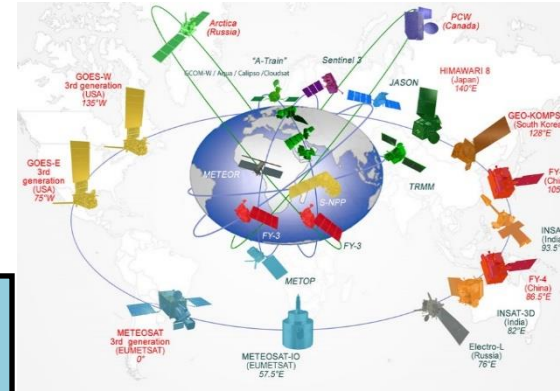
continuously develop advanced NWP systems, with increased reliability and accuracy over India and neighboring regions through research, development, and demonstration of new and novel applications, while maintaining the highest level of knowledge, skill, and technical expertise

”

NWP Process

**Gather
Observations**

**Data
Assimilation**



330 m DM

1.5 km DM

4 km Regional

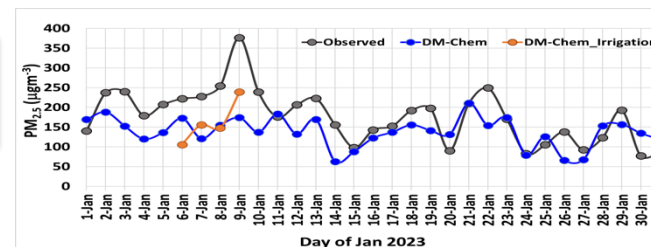
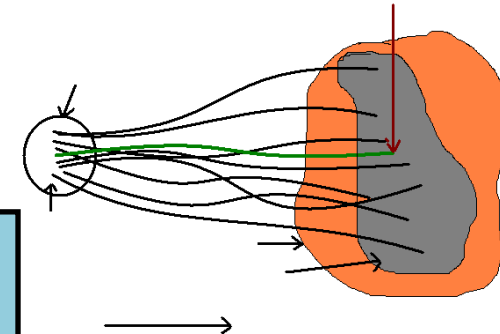
12 km Global

Global
Ensemble
(12km)

Global Coupled
(60km)

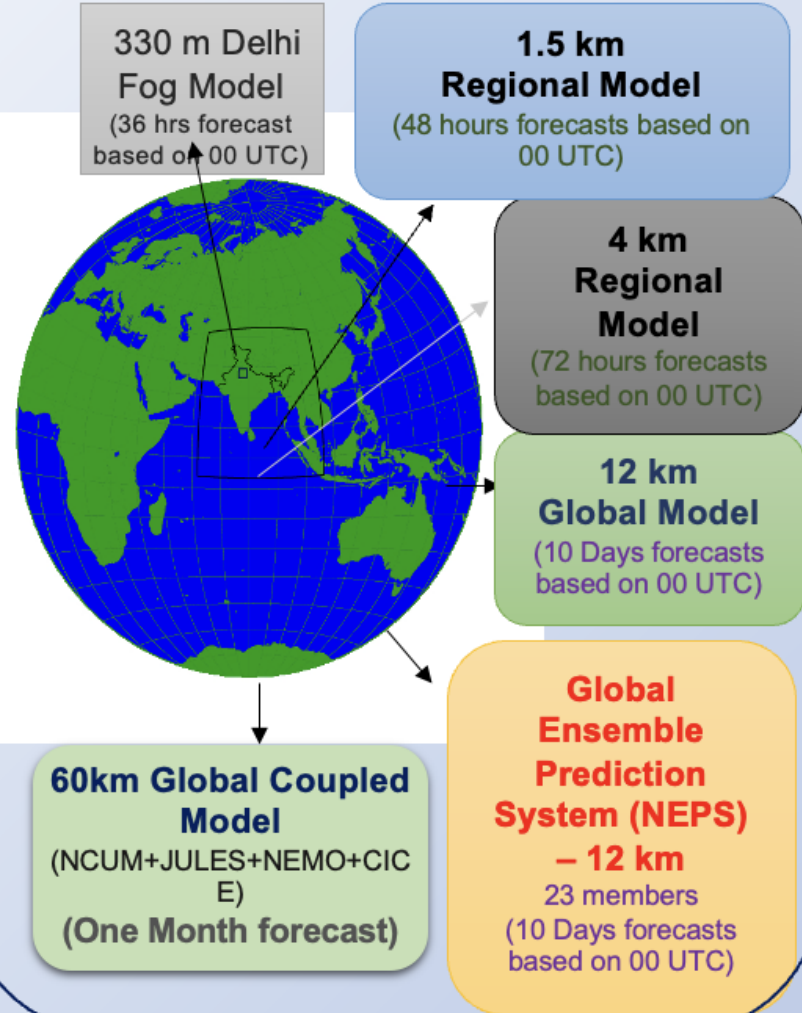
**NWP
Model
Runs**

**Forecast
Postprocessing**



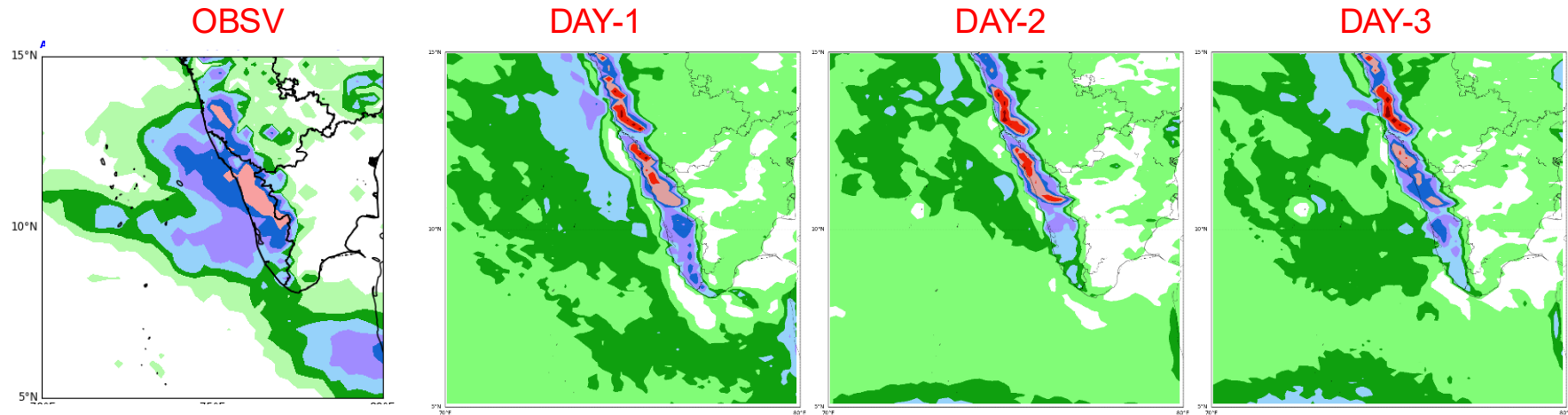
**Issue Model
Forecasts to User
Agencies, Evaluation of
the forecasts, etc.**

NCUM and Data Assimilation System

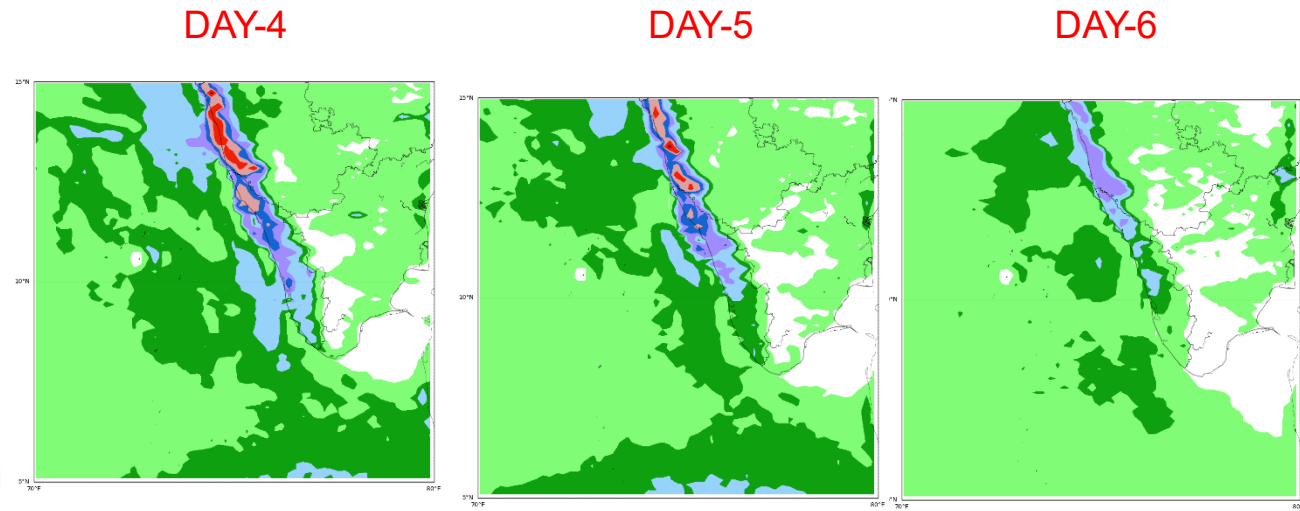


	Urban Model (DM-Chem)	Meso-scale Model (1.5 km)	Regional UM (NCUM-R) (4km)	Global UM (NCUM-G) (12km)	Global EPS (NEPS) (12km)	Coupled UM (CNCUM) (60km)
Domain						
Horizontal resolution	330m	1.5km	4.4 km	12km	12km	Atmosphere: approx. 60 km Ocean: approx. 25 km
Forecast length (IC)	48 hours	48 hours	75 hours(00UTC & 12UTC)	10 days (00,12 UTC)	10 days (00,12 UTC)	1 month (ERP) 3 Months- Seasonal
Ensemble size	-	-	-	-	23	ERP:16 Seasonal: 55 (Only atmosphere)
Initial conditions	Downscaled IC from 1.5km domain	Downscaled IC From NCUM-G	Regional DA (4-D Var)	Global DA (Hybrid 4-D Var)	Global DA Pert: ETKF+SKEB+SP	Atmosphere: Global DA Ocean: NEMOVAR
SST Conditions	Downscaled	Downscaled	OSTIA SST Analysis (EKF)	OSTIA SST Analysis (EKF)	OSTIA SST Analysis (EKF)	Coupled model
Main Products	Visibility/fog AQI Surface weather	Visibility/Fog AQI Surface weather	Precipitation Lightning Wind gust Surface weather	Precipitation Wind TC track and intensity Severe weather	Precipitation Wind TC track and intensity EFI	Various Monthly and seasonal forecast products

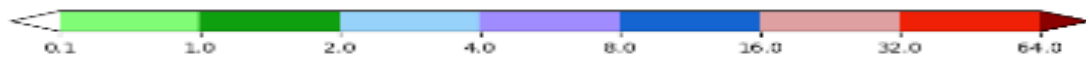
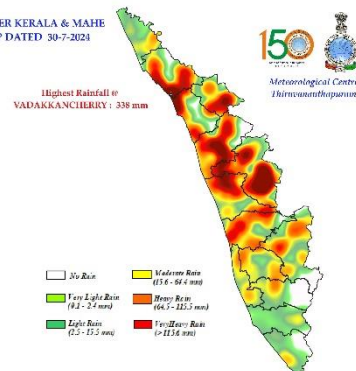
KERALA (WAYANAD) HEAVY RAIN (cm/day) PREDICTION BY NCUM-Global VALID FOR 03Z 30 JULY 2024



Extremely heavy
rainfall forecast (>
32cm) upto
5 days in advance
by NCUM global
model



24 HOUR RAINFALL OVER KERALA & MAHE
AND LAKSHADWEEP DATED 30-7-2024

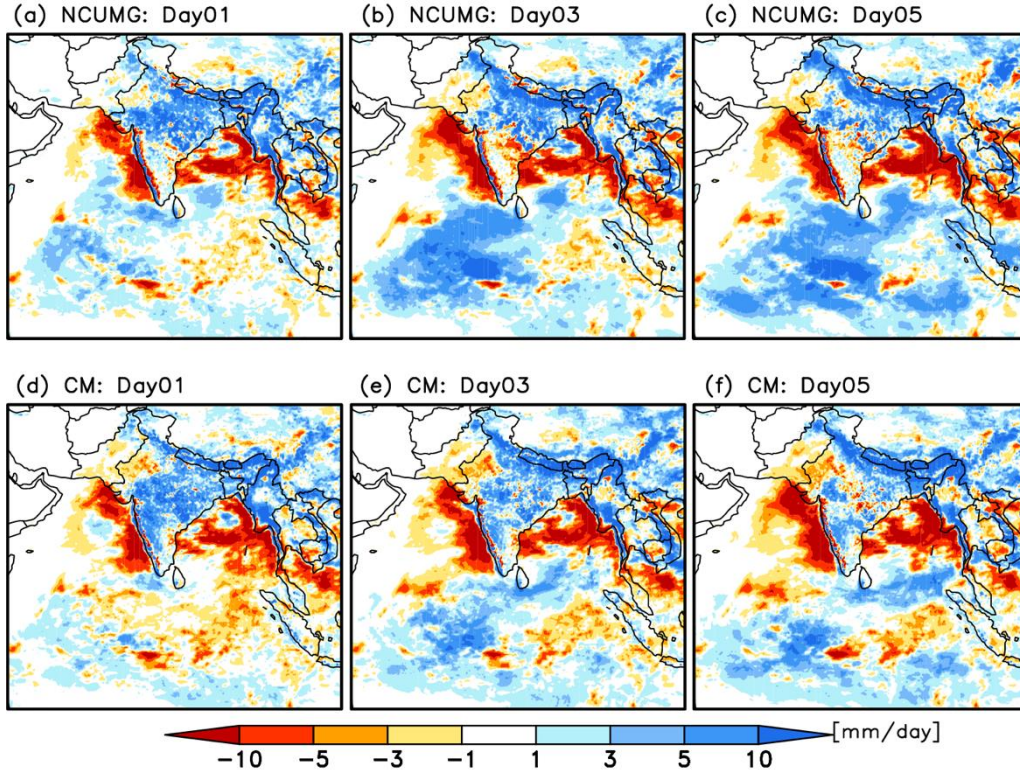


Coupled Model for Medium-Range NWP

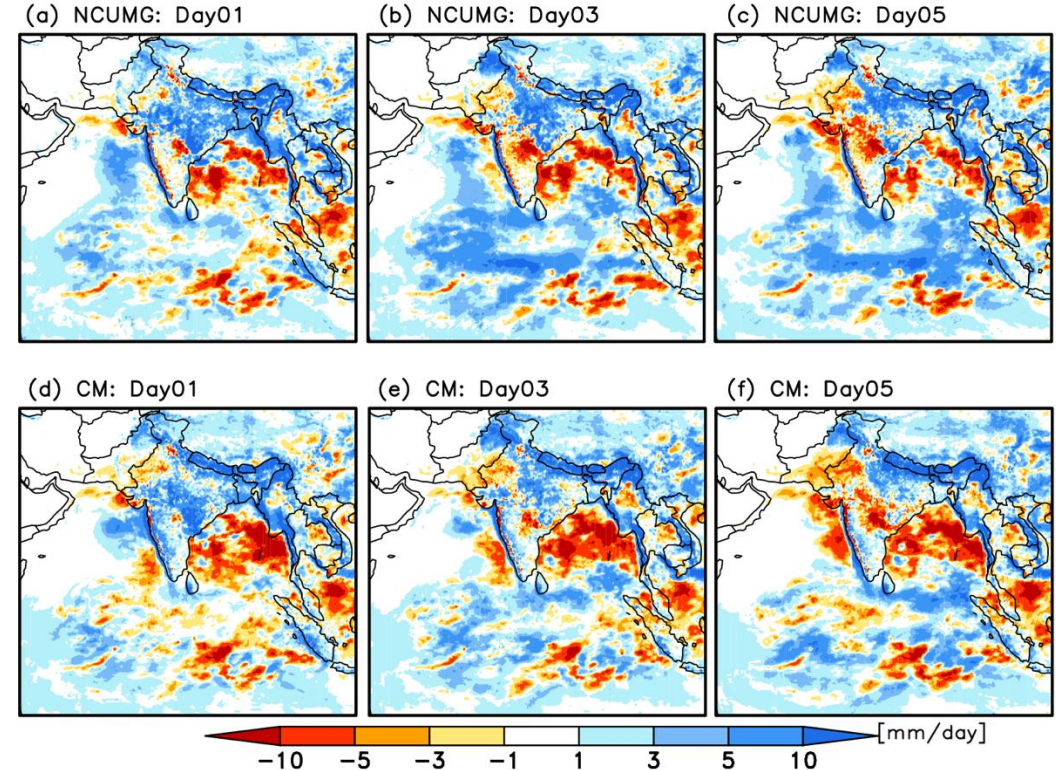
Mean Bias

Coupled Model Forecast has shown reduction in Bias over the eq. Indian Ocean and core monsoon zone

July 2023



July 2024

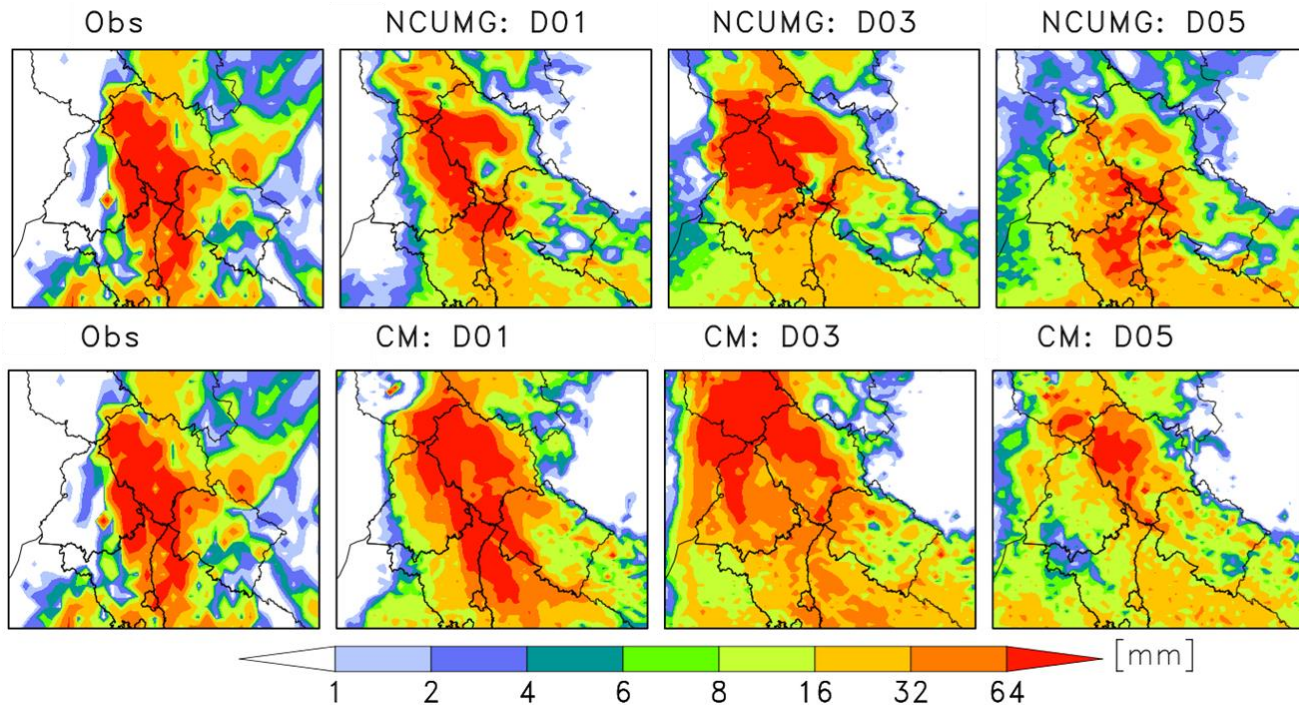


Coupled Global Model : Extreme Event Case study

Himachal Pradesh experienced an unprecedented 436% more rainfall than normal from July 7th to 10th, 2023, resulting in devastating landslides, flash floods, and significant socio-economic losses.

Performance of Coupled Model seems better in long lead times

Forecast Valid for 00 UTC 10th July, 2023



Uncoupled Global Model



Coupled Global Model

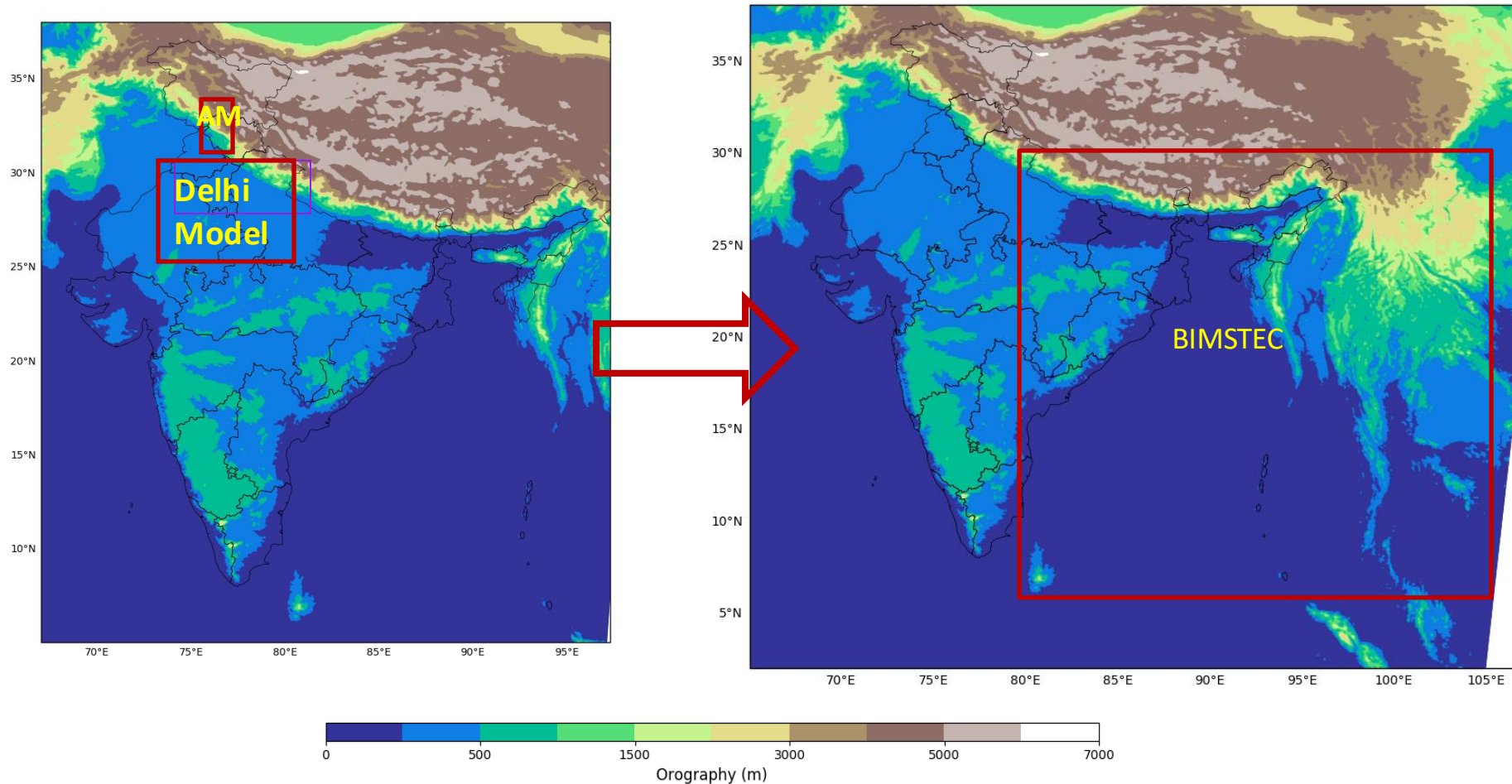
Regional UM (NCUM-R ~ 4km)

- Convection parameterisation is switched off in the model.
- Double moment microphysics (CASIM) and Bimodal cloud scheme.
- Prognostic graupel for lightning prediction.
- SRTM orography (90m source resolution).

Advantages

- Detailed orography and Land surface characteristics (Accurate orographic precipitation)
- Better representation of local storm triggers
- Ability to represent the evolution, structure and secondary development of convective storms

BIMSTEC Activities : Regional model (4km) domain extended

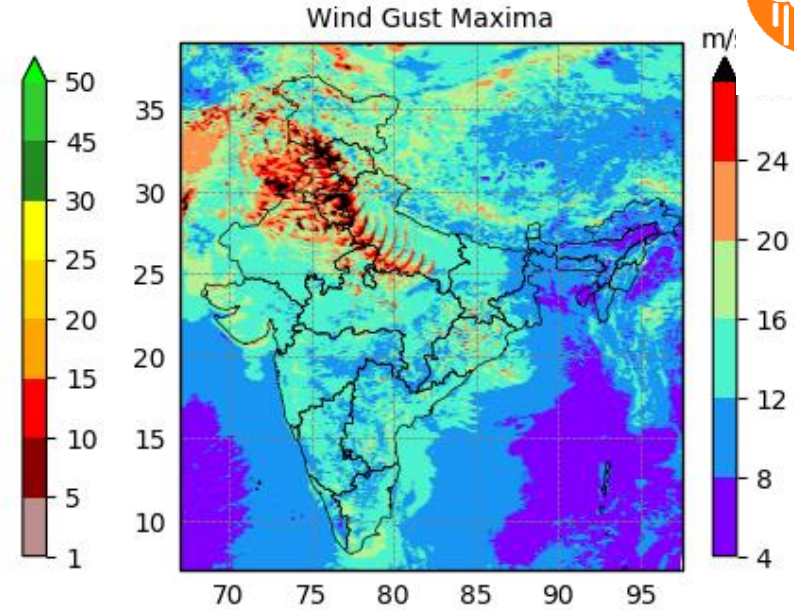
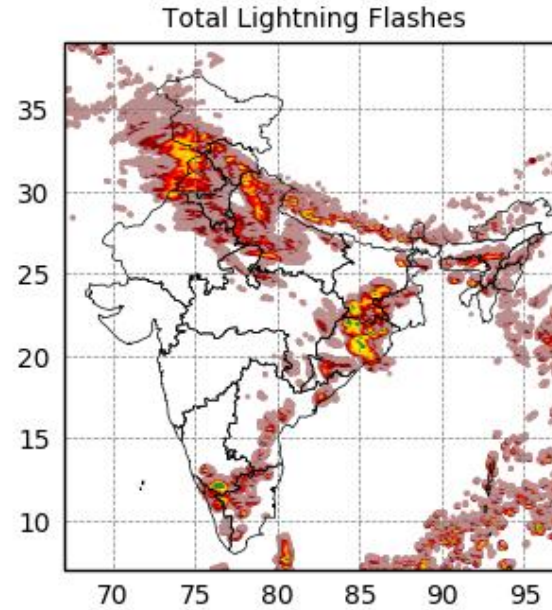


AGRA episode

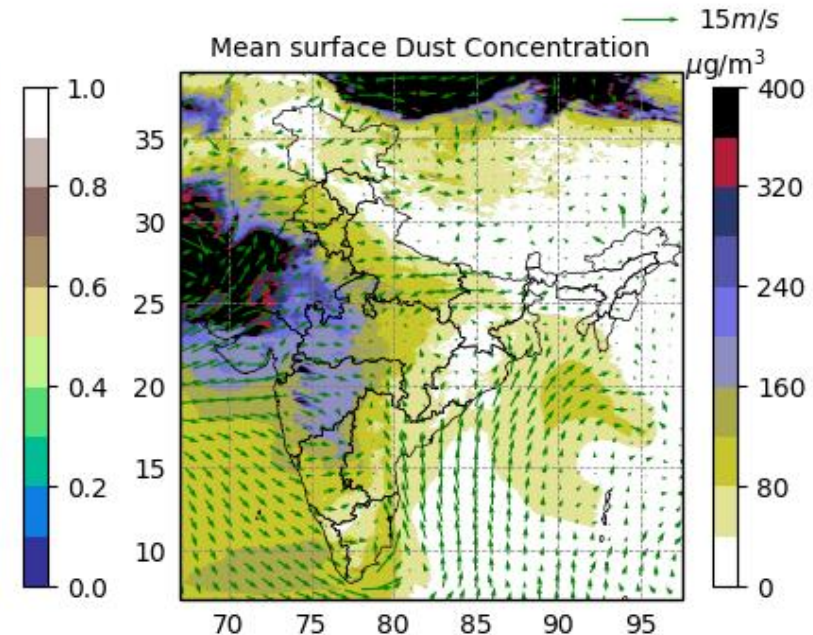
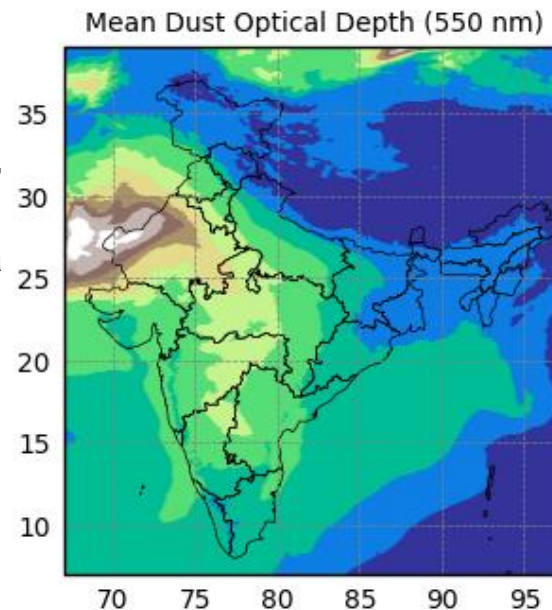
NCMRWF regional 4-km model 24-h Forecast Valid on 20180503
based on IC: 20180502 00UTC



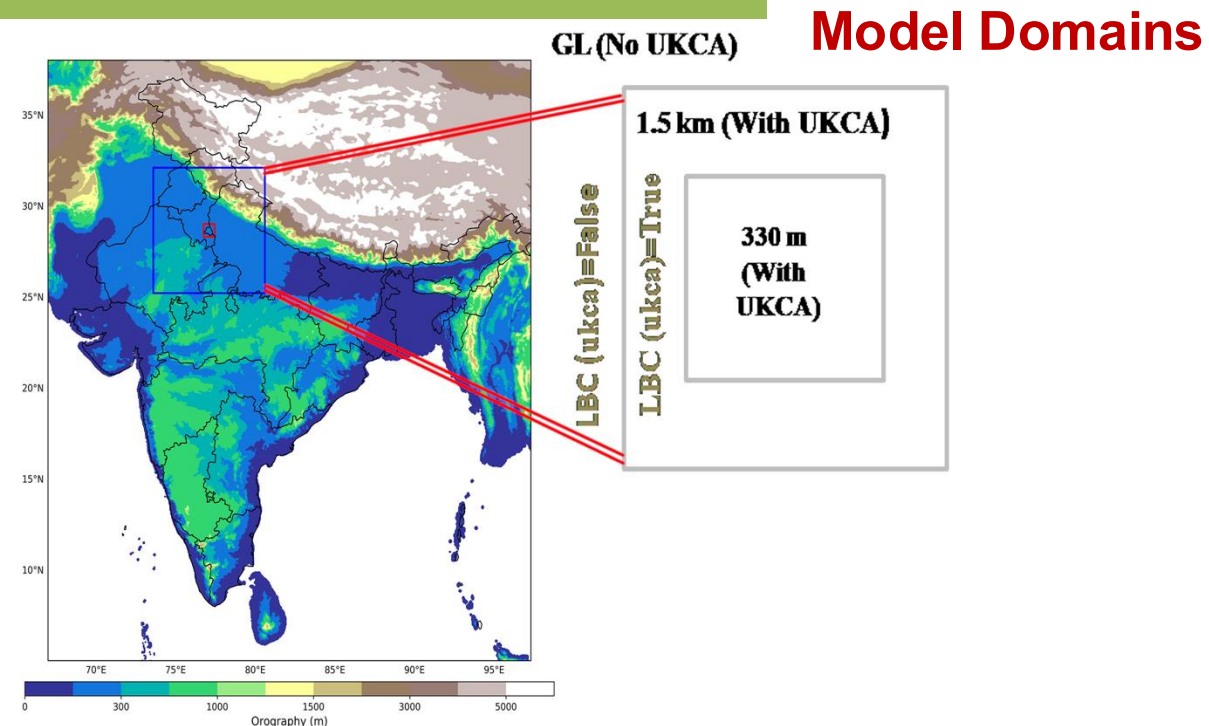
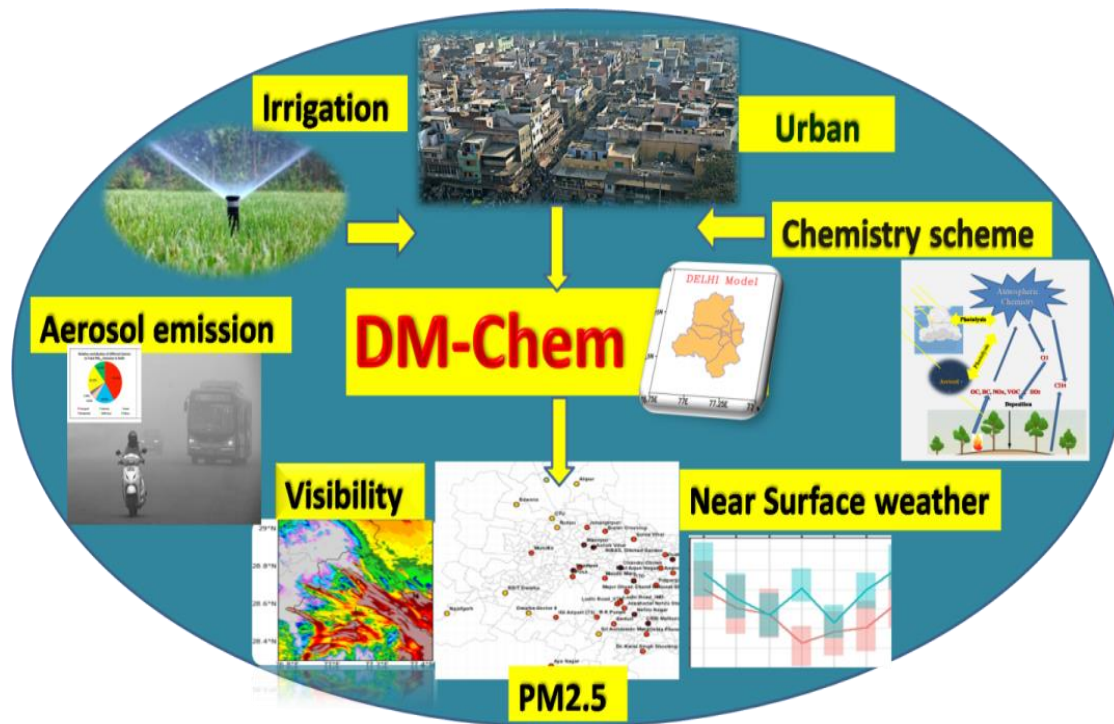
**24-hourly
accumulated
lightning flash
count, Maximum
wind gust over
24-hourly period,
Mean DOD and
Mean surface
dust
concentration.**



**Migration of MCS
towards south-
eastwards along the
Indo-Gangetic plains –
caused severe
thunderstorms at Agra
and simultaneously
severe dust storm
over Rajasthan.**



Upgradation of DM-Chem: DM-Chem v1.0



Emission datasets

1.5 km domain: EDGAR⁺ (0.1° x 0.1°)

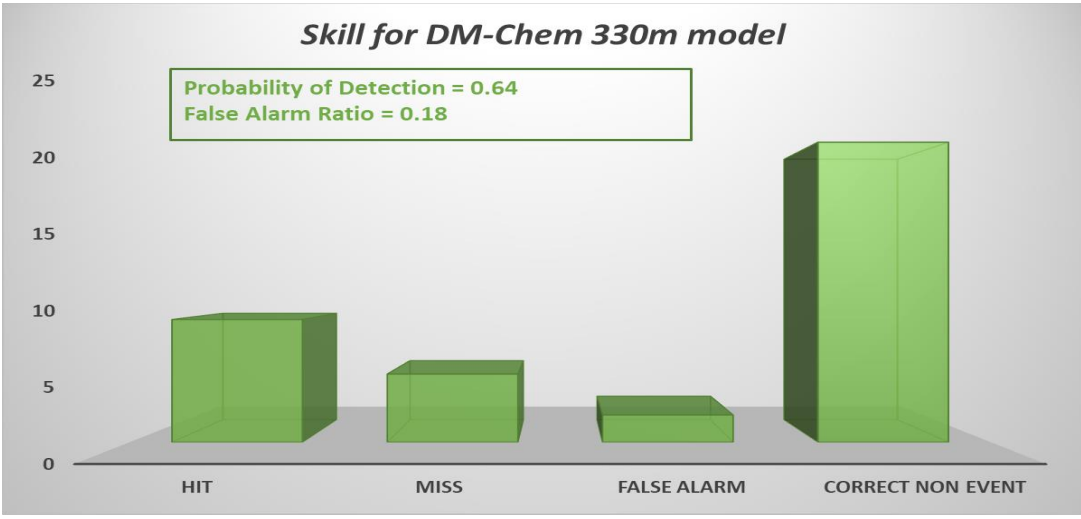
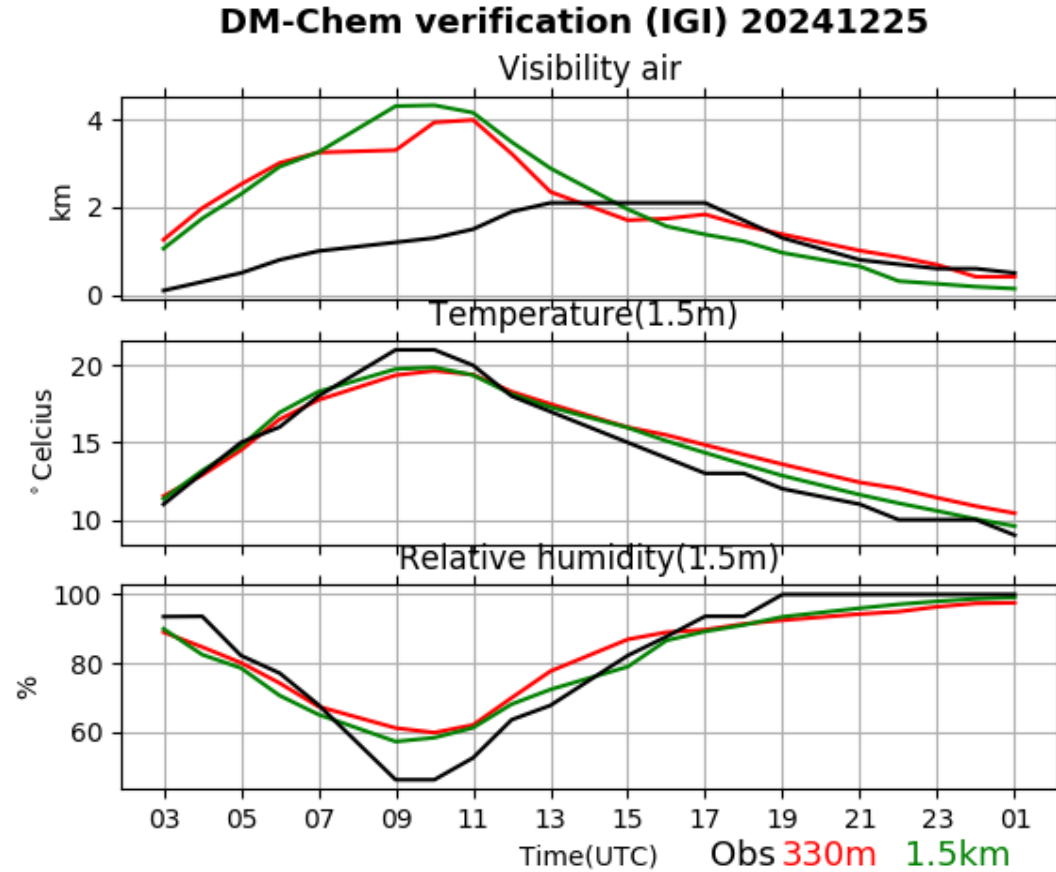
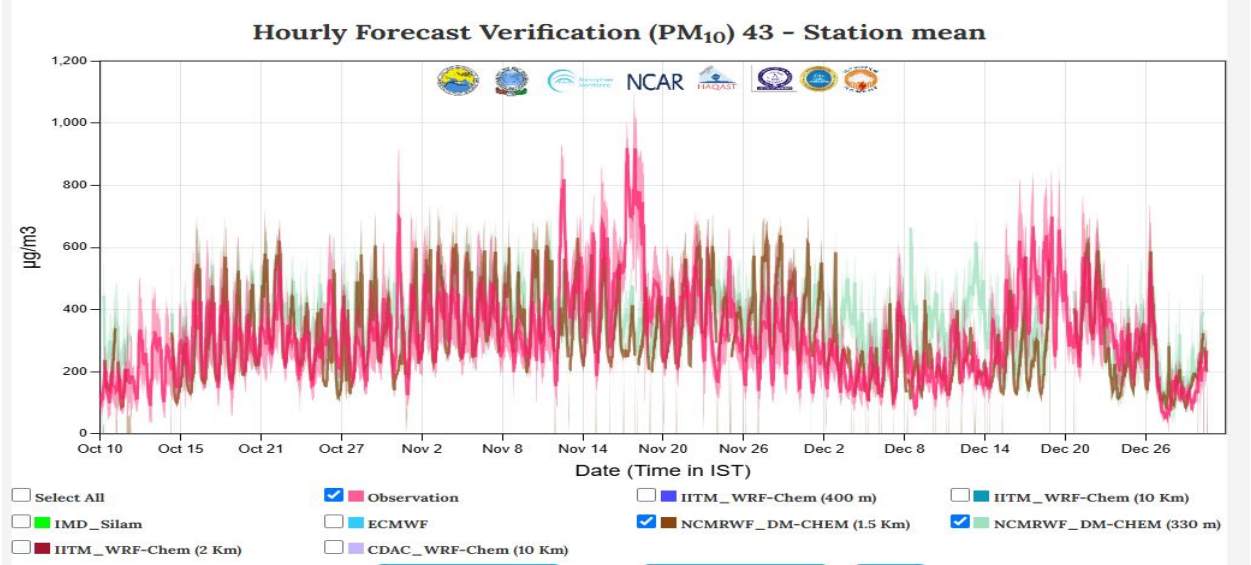
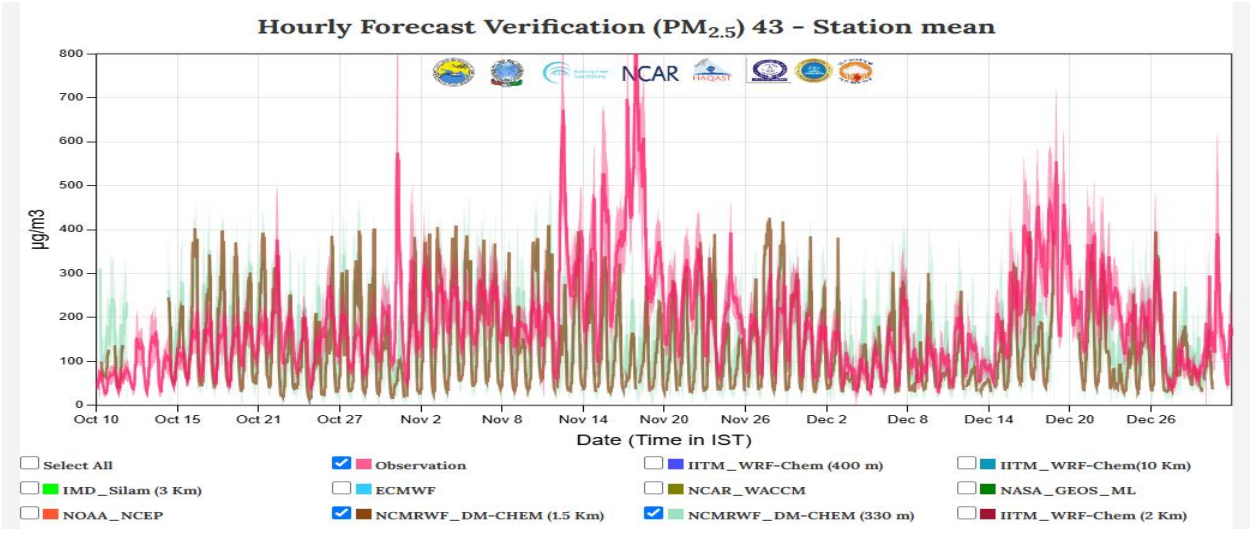
330 m domain: SAFAR⁺ (Sahu et al. 2011).

Biomass burning: Global Fire Assimilation System (GFAS) fire emissions data

* Emissions Database for Global Atmospheric Research
 + System of Air Quality and Weather Forecasting And Research
 UKCA: United Kingdom Chemistry and Aerosols Model

1. **MORUSES Urban parameterization scheme using Delhi morphology**
2. **Prognostic chemistry aerosol scheme (reduced) coupled to double moment microphysics scheme (CASIM)**
3. **Irrigation representation through soil saturation**

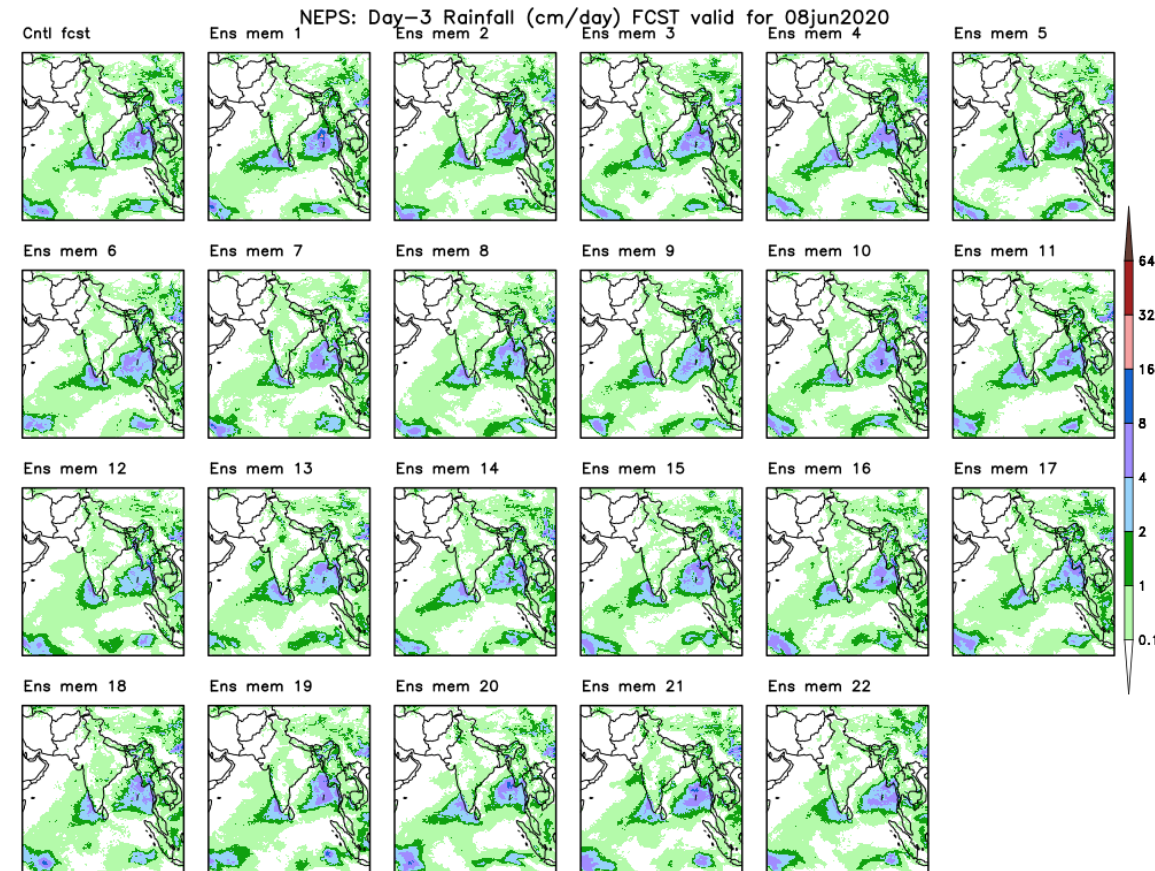
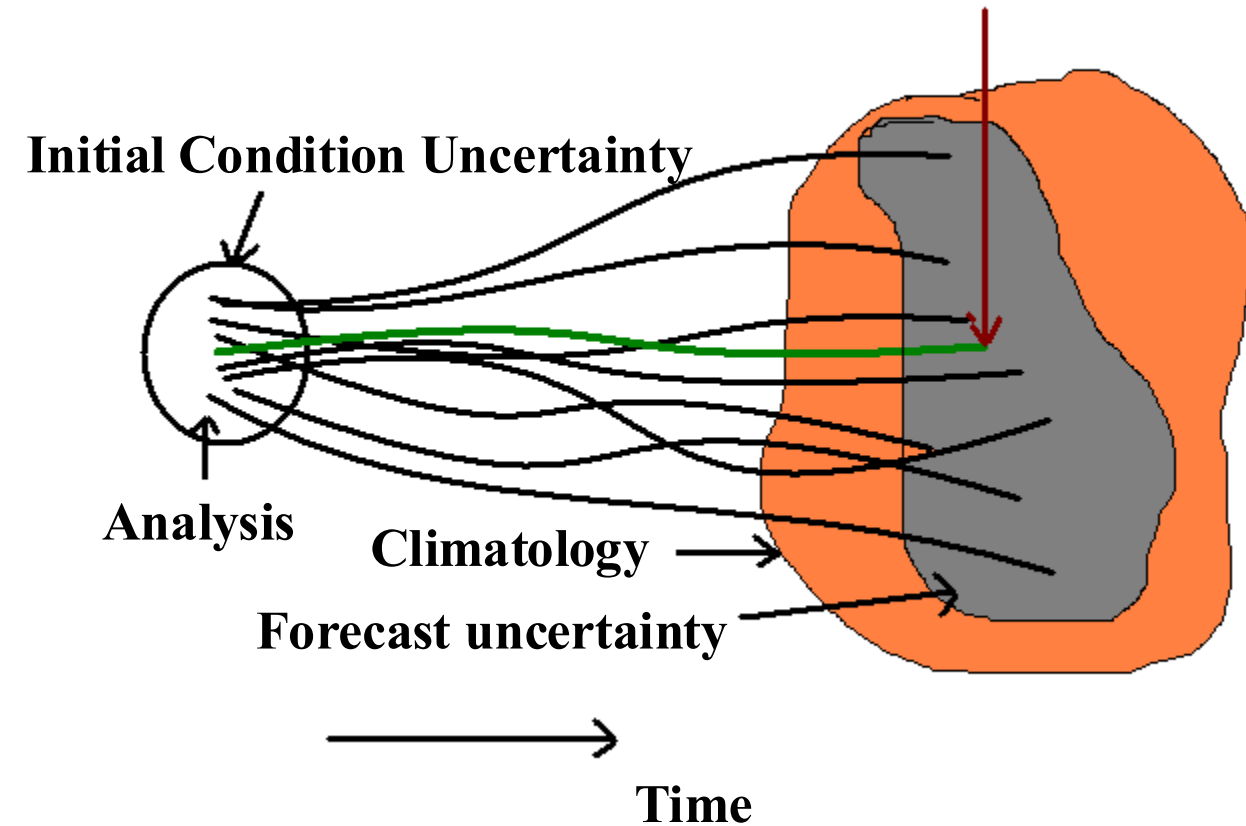
DM-Chem performance during winter season 2024-25



Ensemble Prediction System (EPS)

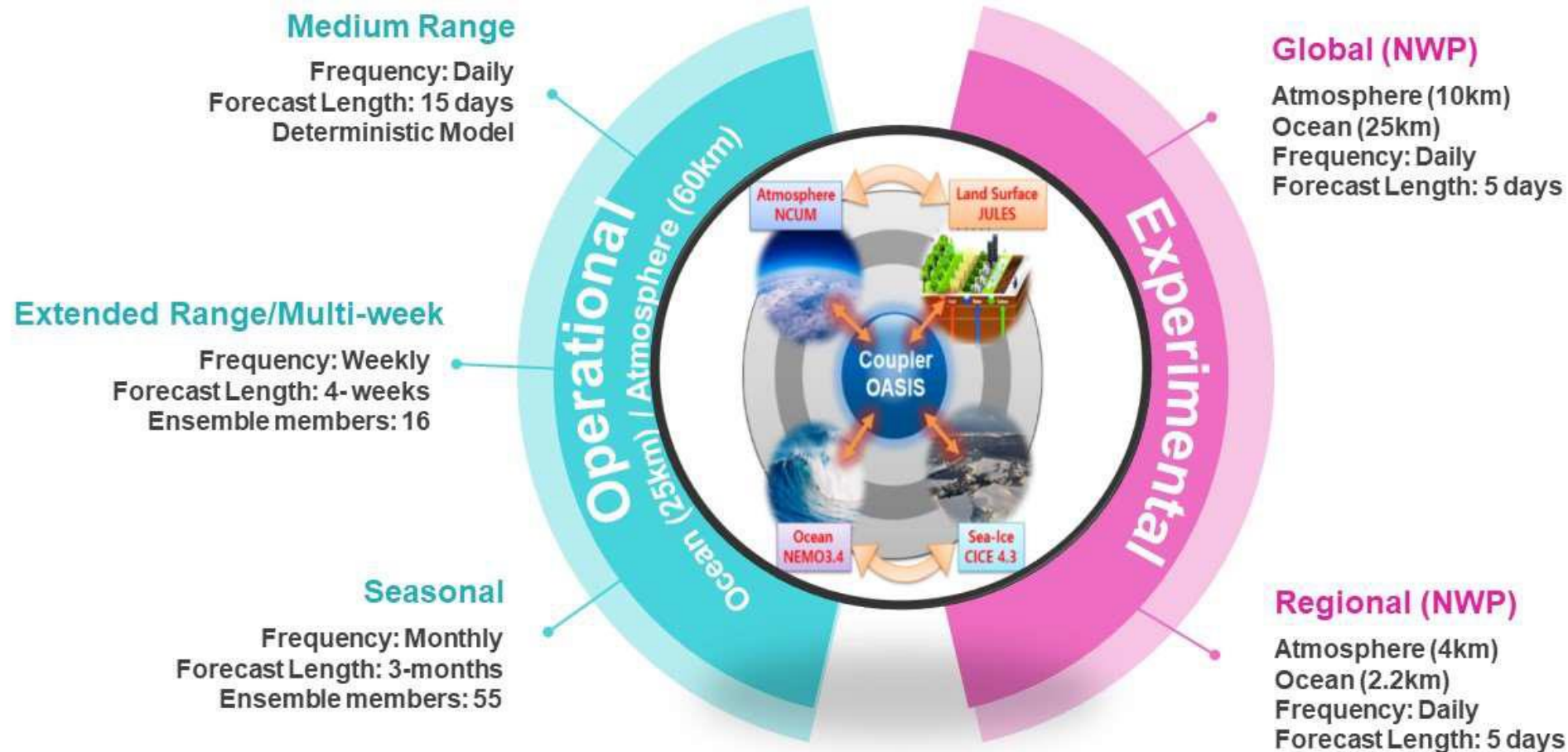
EPS provides a way of quantifying the uncertainty in forecasts

Deterministic Forecast



Operational Runs of Global Coupled Model (60 km) for S2S Forecast (NCUM+JULES+NEMO+CICE)

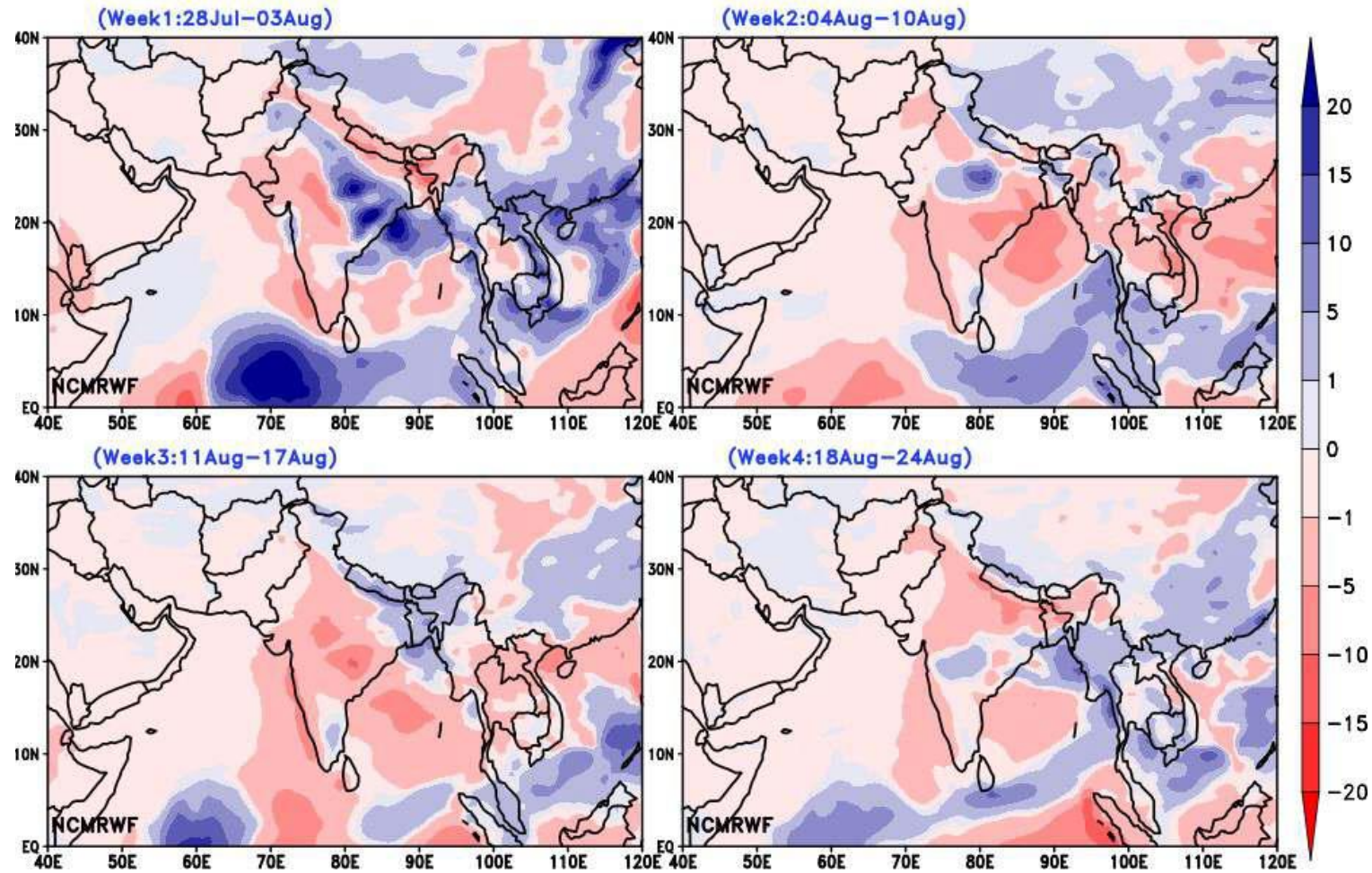
NCMRWF Coupled Modelling



Extended Range (Multi-Week) from Coupled Model

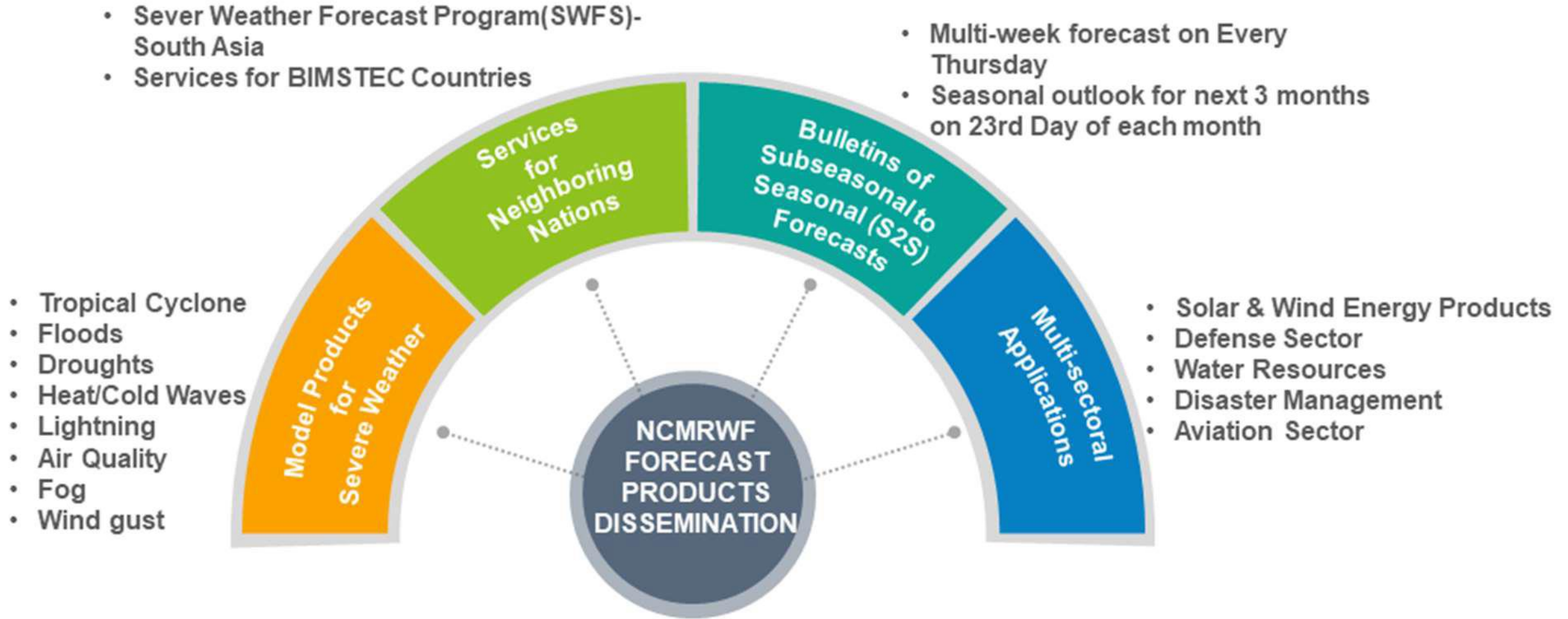
NCMRWF ERP Forecast: Issued on 27Jul2023

Precipitation Anomaly (mm/day)



Extended Range Prediction is done using **ocean-atmosphere coupled dynamical model**. The Extended Range forecasting system consists of 16 members forecast with physical perturbations. This system is run weekly and issues 4-week outlook

Sector wise applications of NCMRWF products



ARUNIKA HPC CONFIGURATION AT NCMRWF



Atos BullSequana XH2000 DLC System

AMD 7643
Total Nodes = 2115
PF Size = 7.47PF
HDR 200 GBps/port

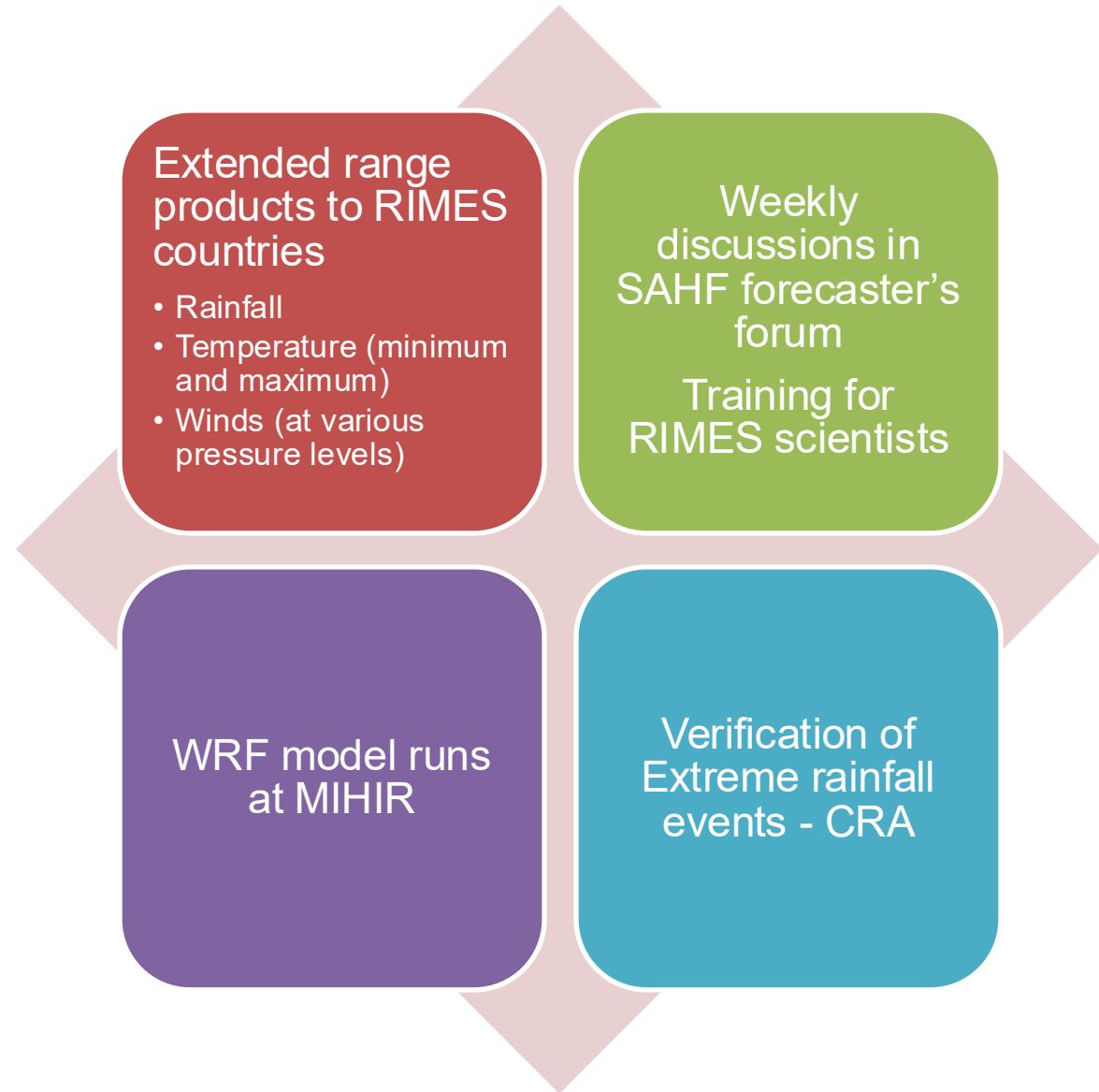
Total # of Racks = 25
Total Power = 1.665 MW

DDN Storage

Total PB = 22.47 PB
of Racks = 5
Total Power = 0.1 MW

DataCentre
Total Power = 2.295 MW

RIMES activities at NCMRWF



Weekly discussion on SAHF forecaster's forum

Every Thursday, the extended range (weekly forecasts from coupled model output) is shared among the RIMES countries and NCMWRF scientists (Dr Mohan and Dr Ankur) actively participate in the forecaster's forum.

In addition, once in a month along with weekly forecasts seasonal forecasts also shared.

Coupled products – Extended range (weekly

NCMRWF Coupled Model Runs with 60 km NCUM and 25 km NEMO W

Weekly Anomalies computed from Model Climatology 23 years. Hindcast data used (1993-2015) from 6 members.

This Forecast is from 16 ensemble members.

- Weekly rainfall
- Temperature (Tmax and Tmin)
- Winds at standard pressure levels (850, 500, 200 hPa)
- SST
- SSH
- Mixed layer depth
- Surface currents

ERP products to RIMES countries

NCMRWF Extended Range Forecasts: 20250501
Precipitation Anomaly (mm/day)

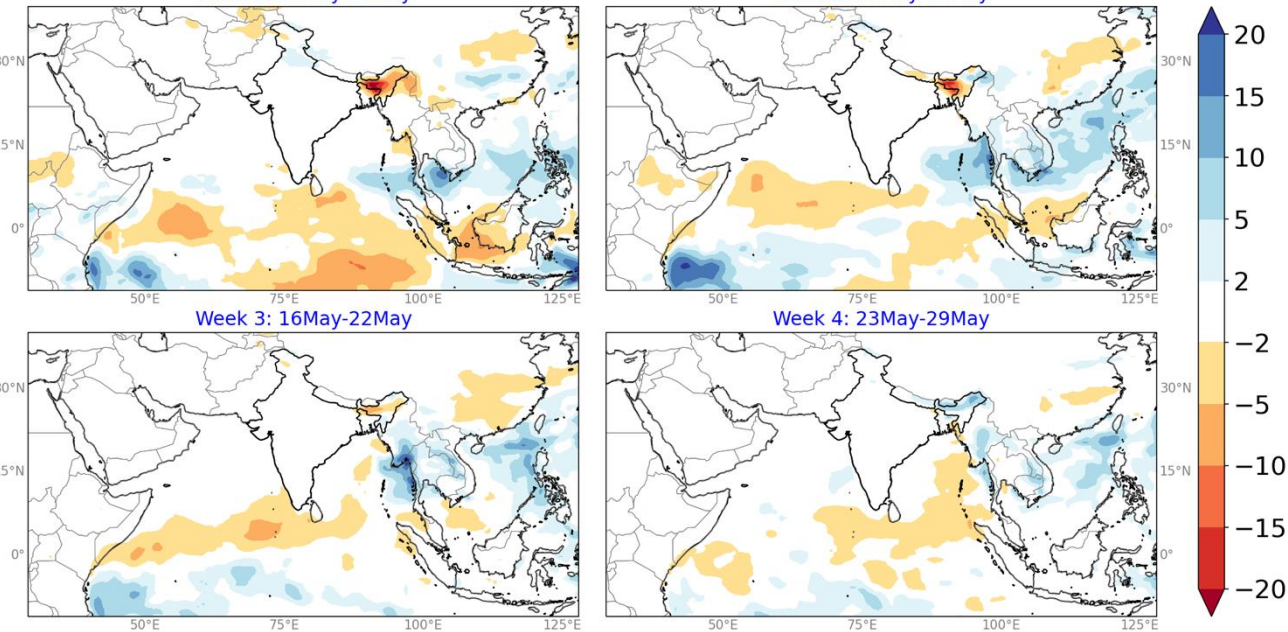


Week 1: 02May-08May

Week 2: 09May-15May

Week 3: 16May-22May

Week 4: 23May-29May



NCMRWF Extended Range Forecasts: 20250501
Precipitation (mm/day)

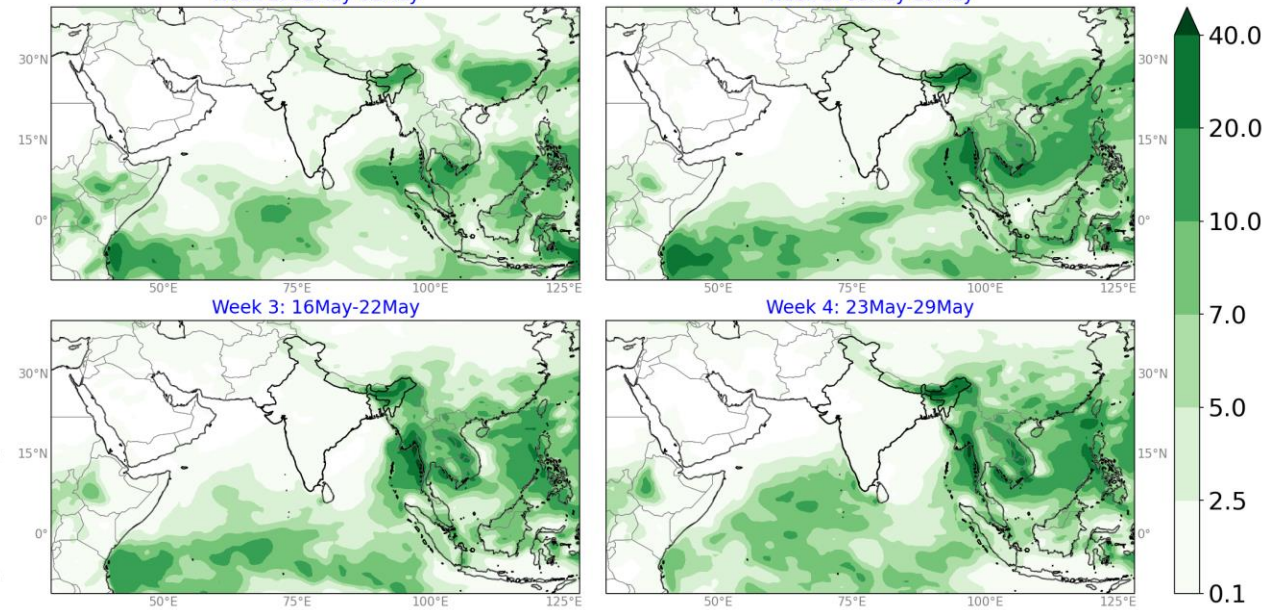


Week 1: 02May-08May

Week 2: 09May-15May

Week 3: 16May-22May

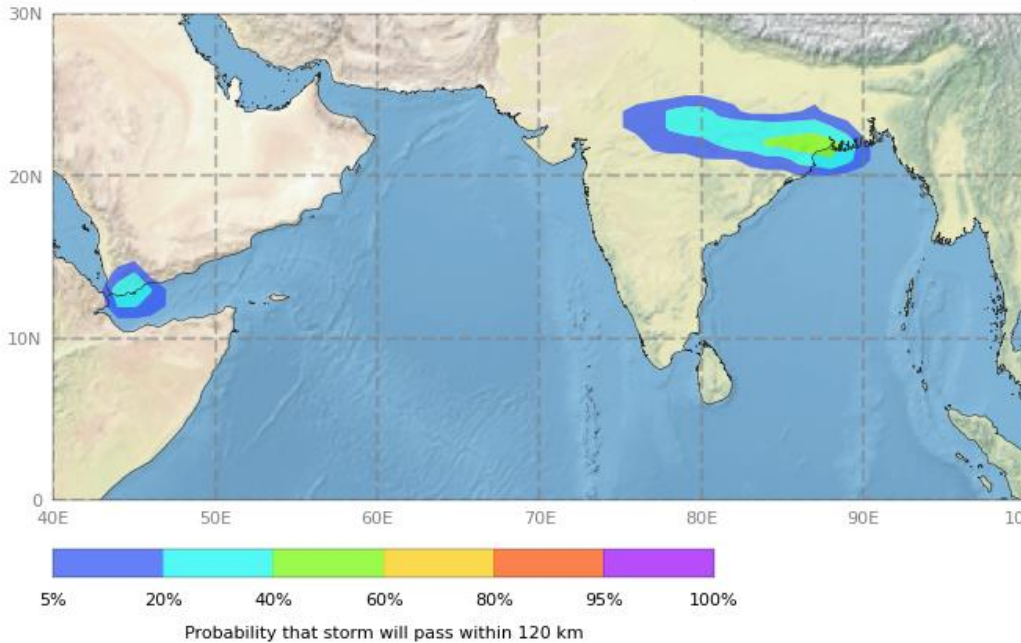
Week 4: 23May-29May



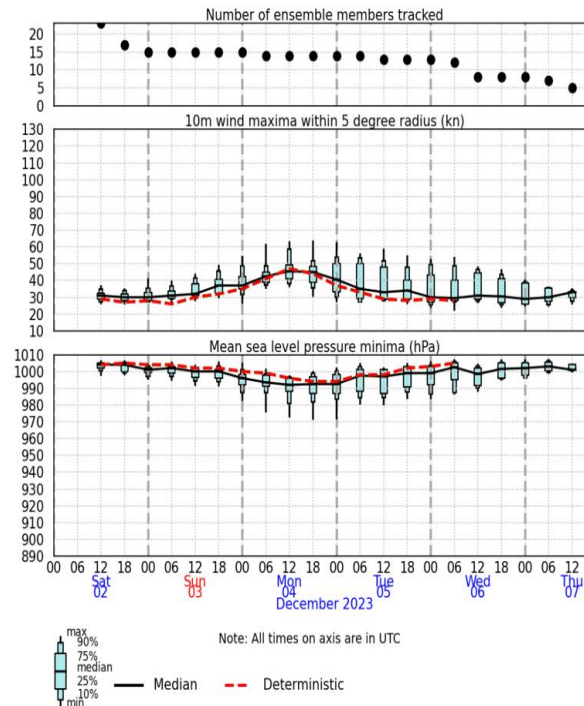
Ensemble products – Tropical cyclone

Strike probability

NEPS-G_12km_22mem: Forecast TC activity (named and forming storms)
in the North Indian basin from 12 UTC Fri 26 Jul 2024
Composite over the next 5 days



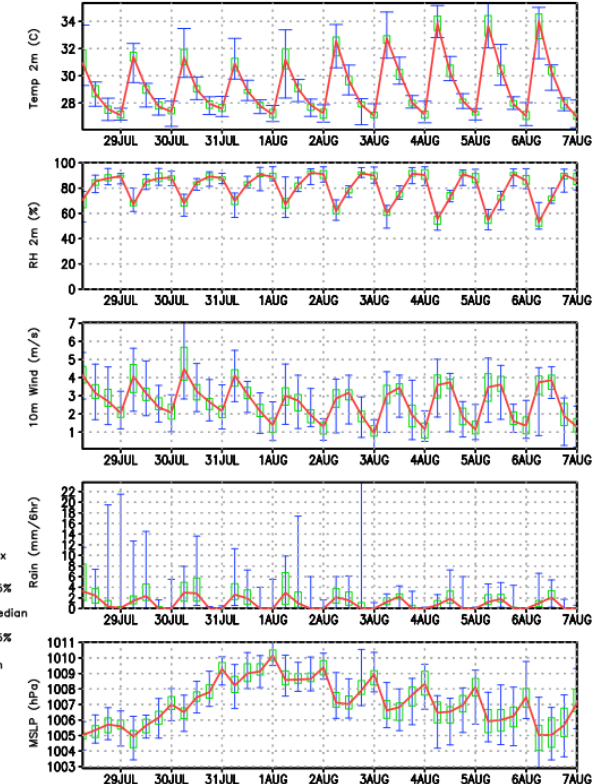
NEPS-G_12km_22mem ensemble: TC-following meteogram
95B (11.1N 83.4E) from 12 UTC Sat 02 December 2023



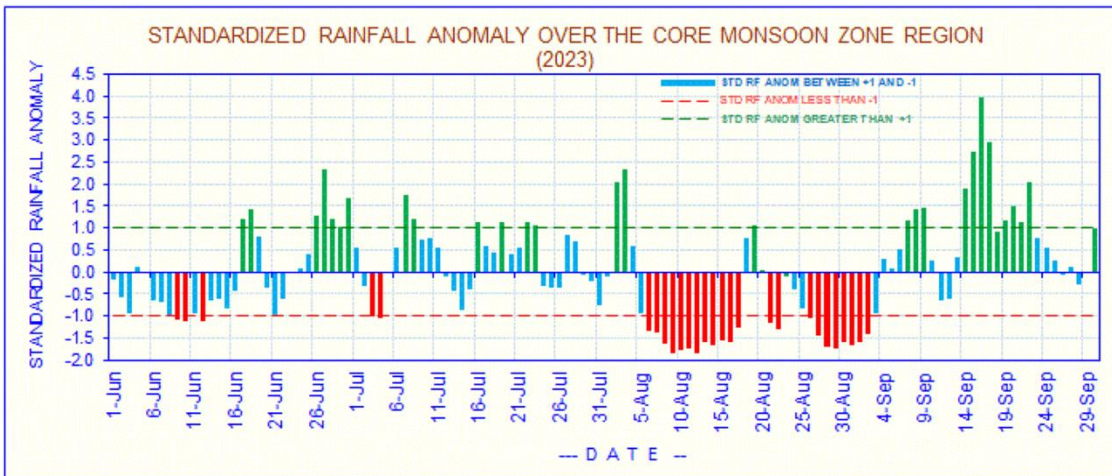
EPSgram

Bangkok

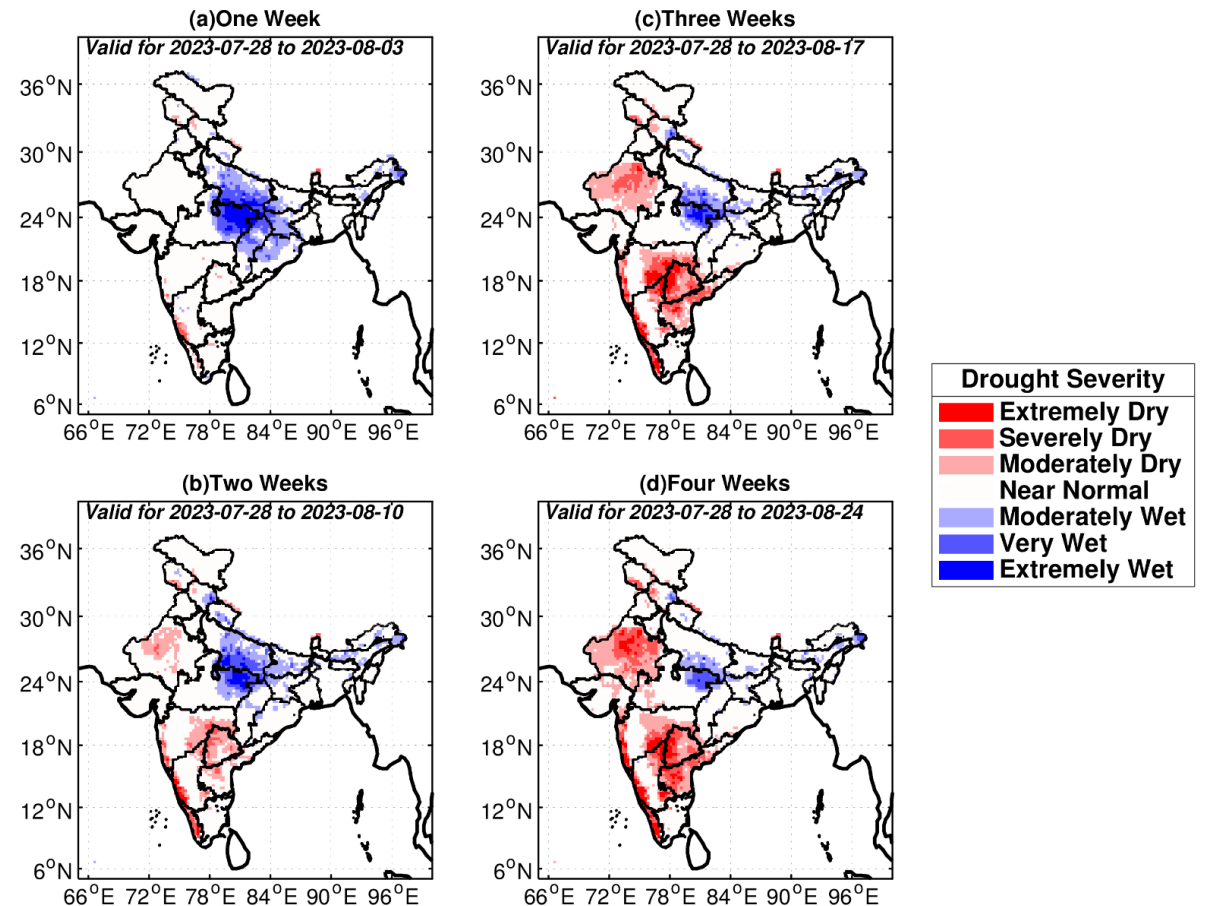
NCMRWF Global EPS Forecast based on 00Z 28JUL2024



ERP Drought product



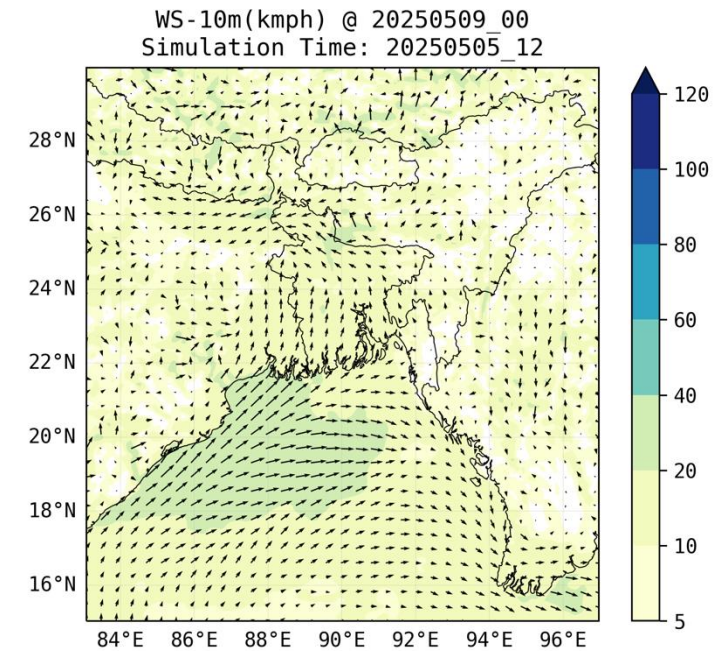
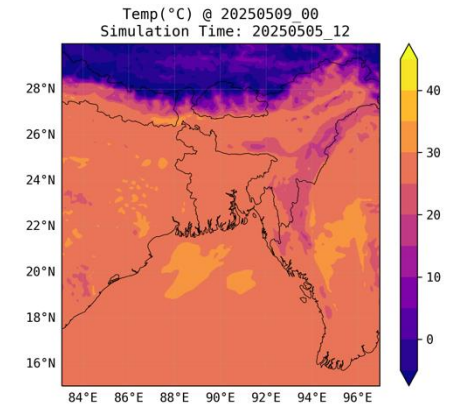
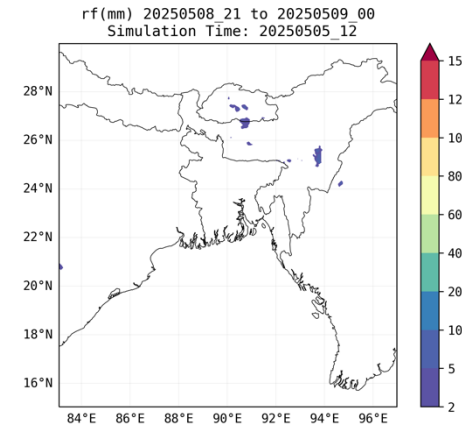
NCMRWF Extended Range Prediction System
Multi-Scalar Drought[SPI] Outlook
released on Jul 27, 2023



- Need bias correction
- It can be extended to all the south Asian countries
- Temperature, rainfall
- Quality surface observations are warranted

WRF-IMDGFS

- WRF runs using IMD GFS over RIMES countries
- Generate rainfall, temperature (Tmax and Tmin) and winds at 10m products over RIMES countries



Training for RIMES scientists

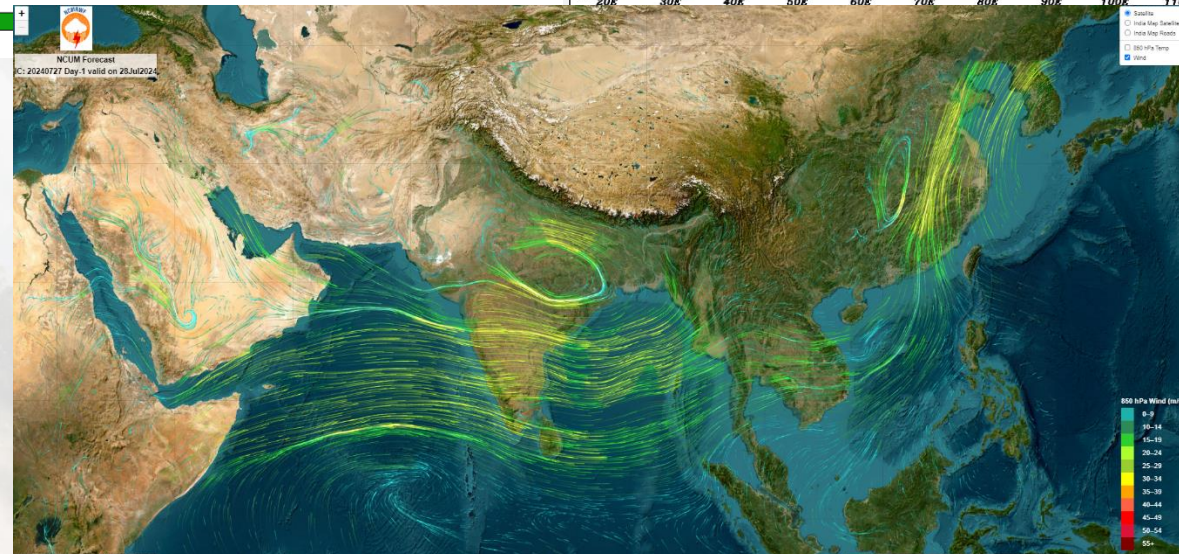
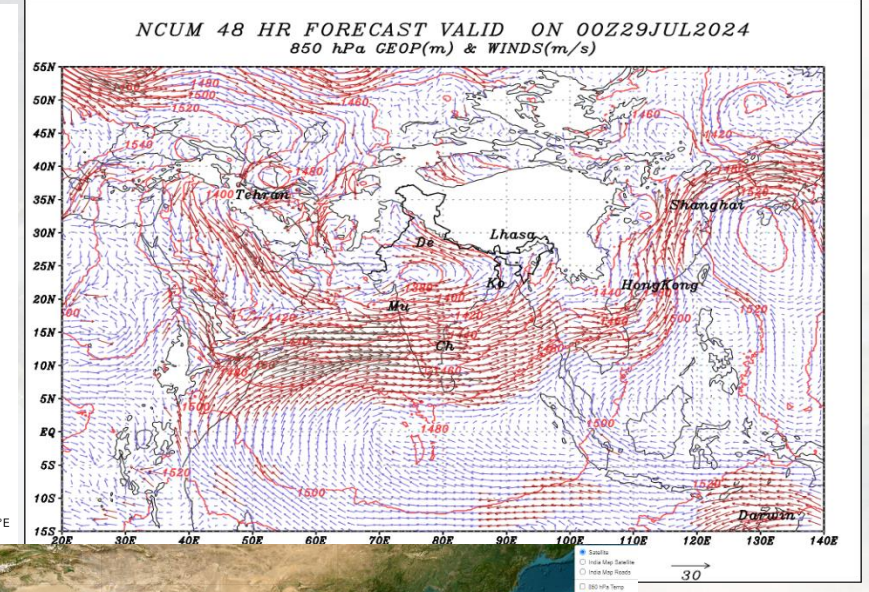
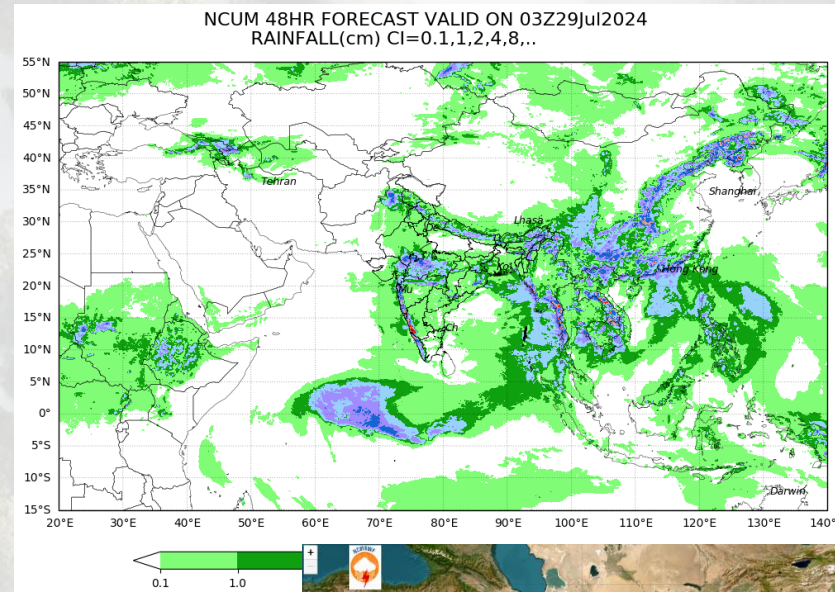
- On 23-27 September 2024 NCMRWF conducted training for RIMES scientists on advanced verification techniques
 - Bias correction methods
 - Model output verification using MET and MET-plus
 - Process-oriented diagnostics
 - Using ensemble data for extreme rainfall verification

NCUM Global model products

- NCMRWF UM Global model – NCUM (12km)
- 10 day forecasts (00 and 12 UTC cycles)
- Rainfall
 - Winds at standard pressure levels (850,700,500,200 hPa)

Forecast charts – over South Asian Monsoon region

Digitized data - in “grib” format is available over the globe



NCUM Regional Model products

NCMRWF UM regional model – NCUM (4km)
3 day forecasts (00 and 12 UTC cycles)

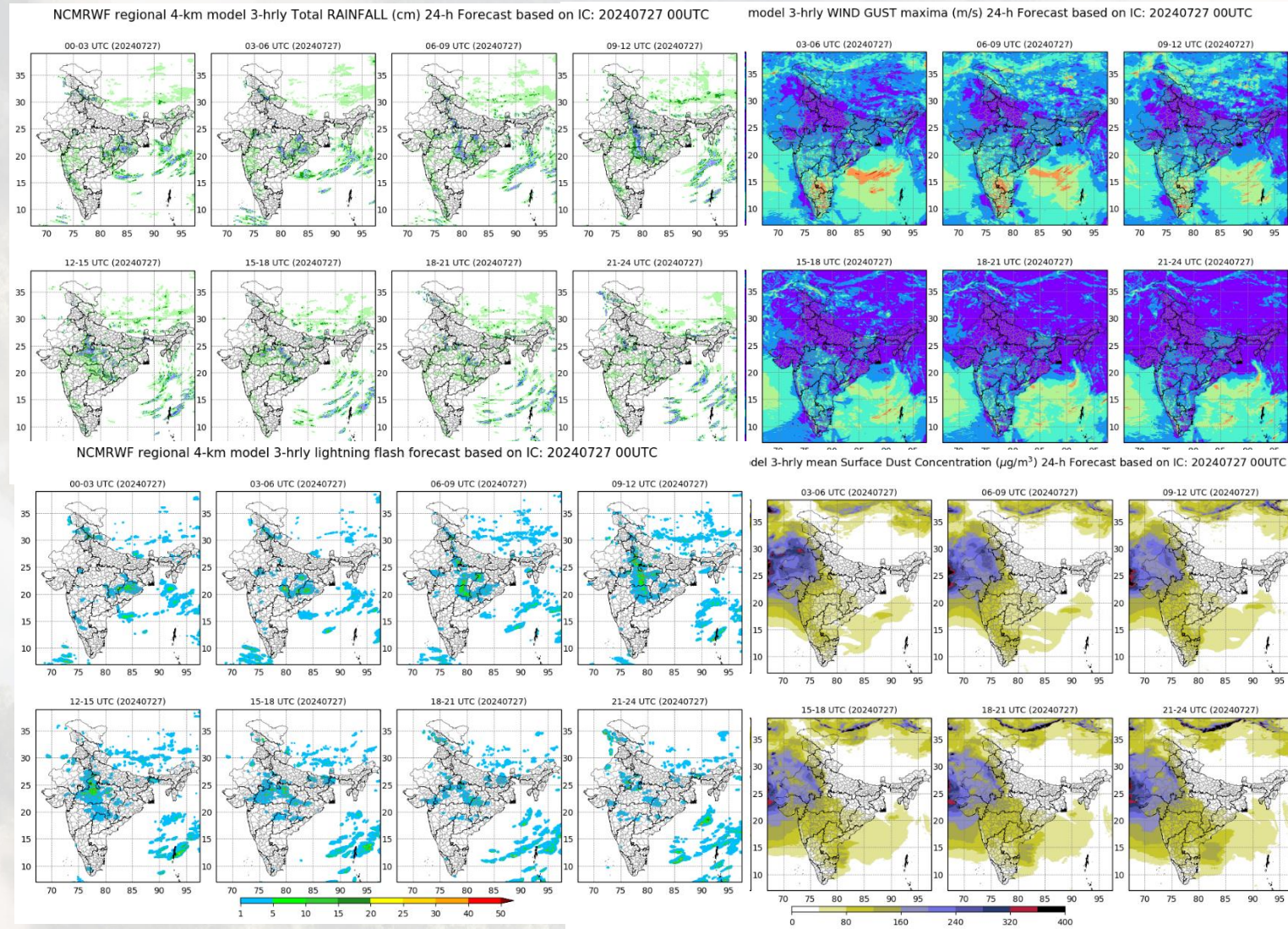
- Rainfall
- Winds at standard pressure levels (850,700,500,200 hPa)

Diurnal products

- *Rainfall*
- *Gust winds*
- *Lightning*
- *Dust concentration*

- Forecast charts – over limited region (Nepal, Bhutan, Bangladesh, parts of Pakistan, Myanmar and Thailand)

- Digitized data - in “grib” format is available over limited region covering Indian subcontinent.



Coupled products – Extended range (weekly forecasts)

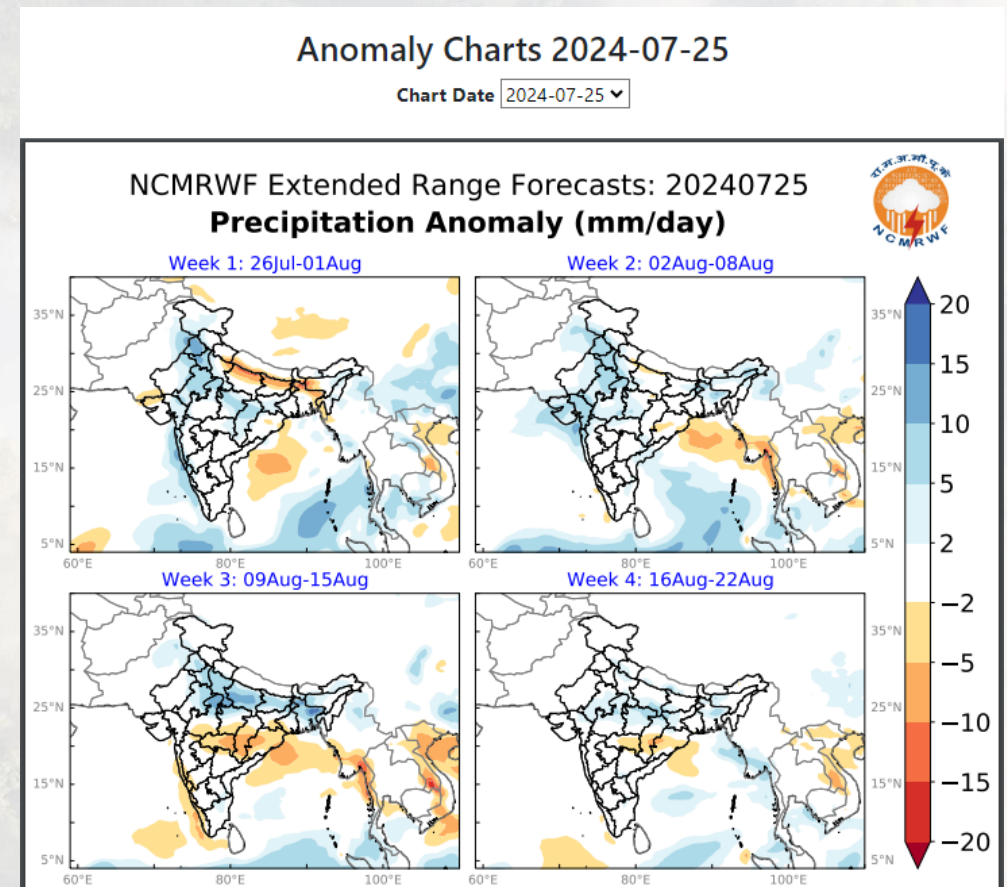
NCMRWF Coupled Model Runs with 60 km NCUM and 25 km NEMO W

Weekly Anomalies during 12 Jul 2024-8 Aug 2024

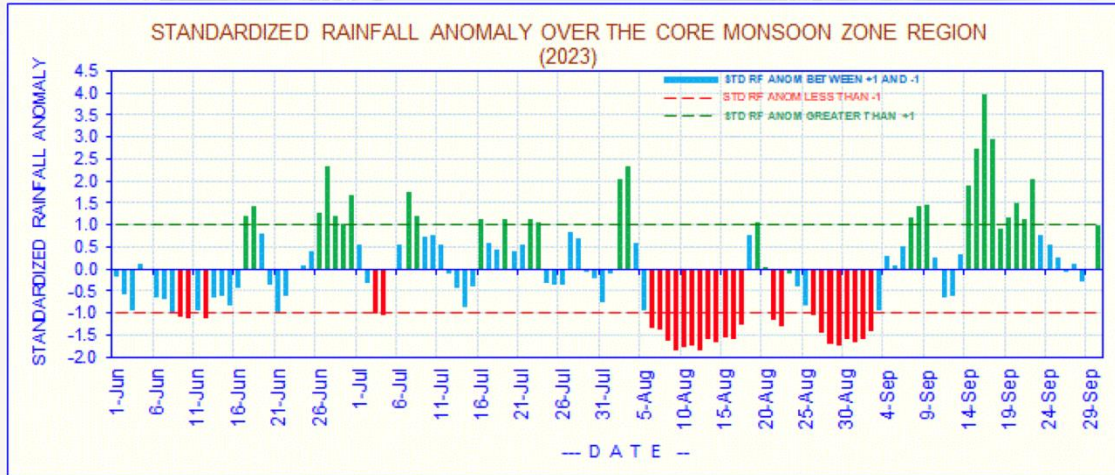
Model Climatology 23 years. Hindcast data used (1993-2015) from 6 members.

This Forecast is from 16 ensemble members.

- Weekly rainfall
- Temperature (Tmax and Tmin)
- Winds at standard pressure levels (850, 500, 200 hPa)
- SST
- SSH
- Mixed layer depth
- Surface currents

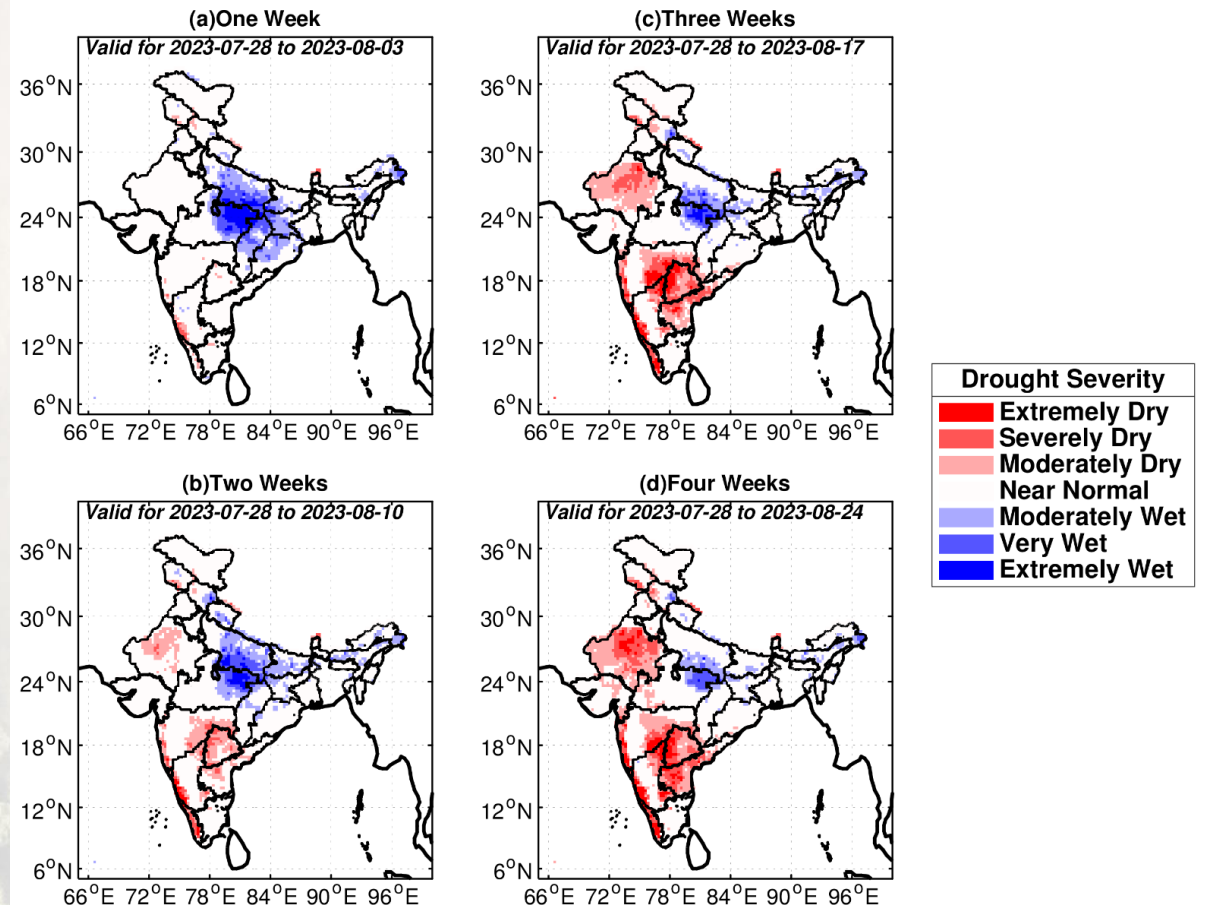


ERP Drought product

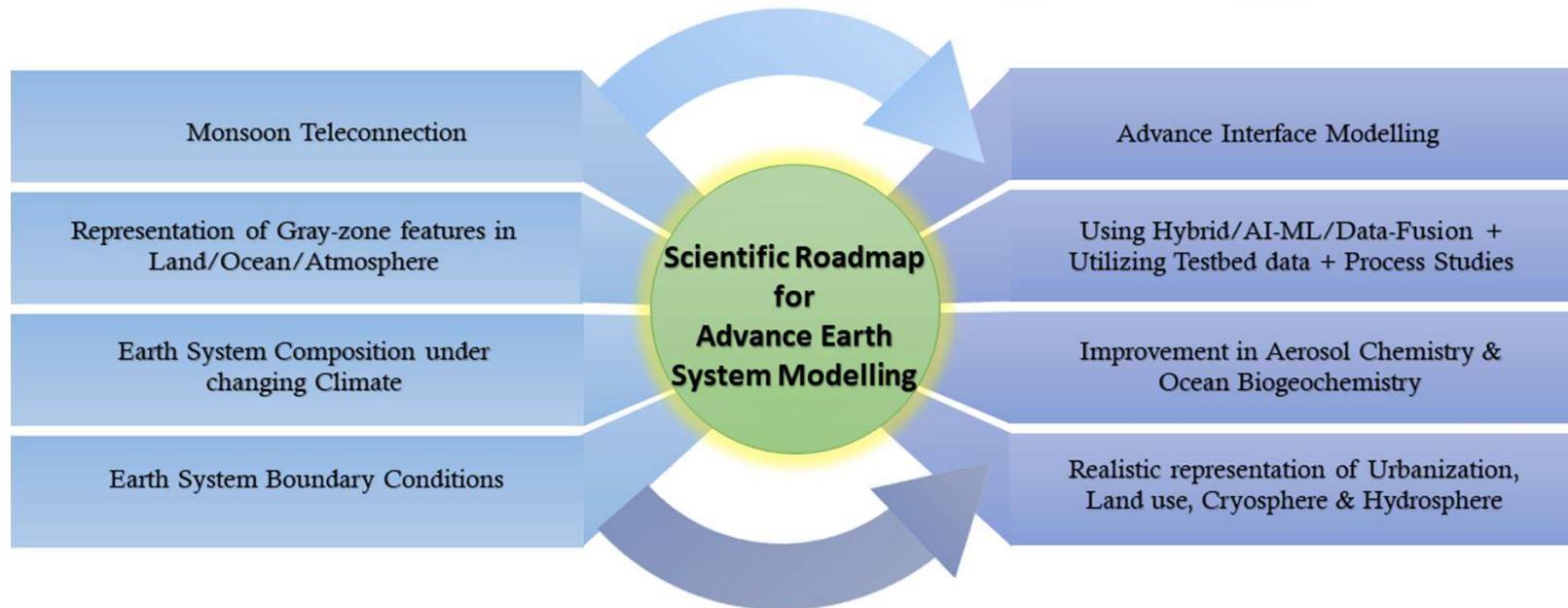
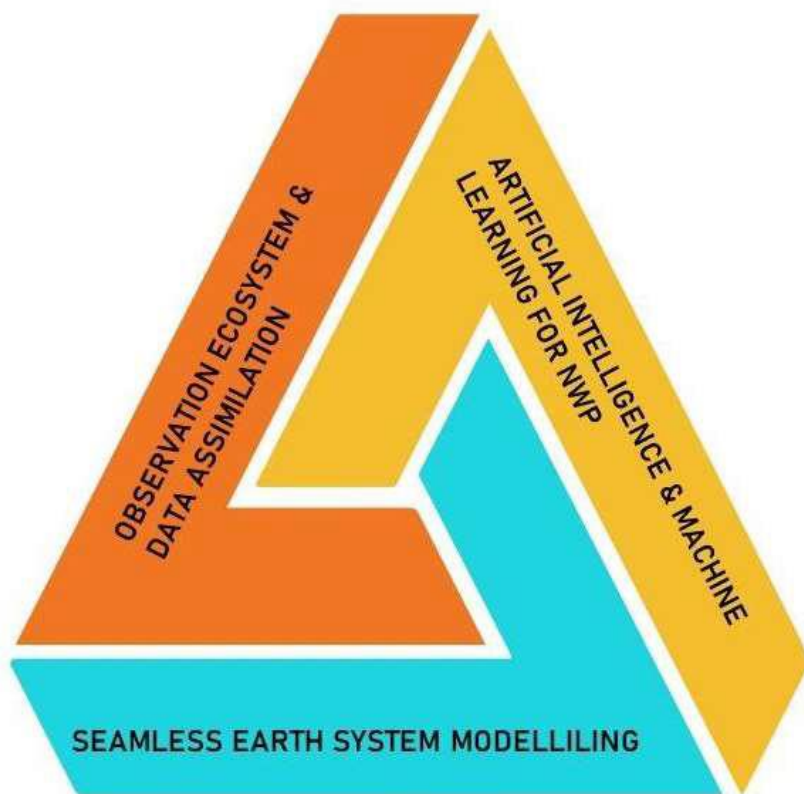


- Need bias correction
- It can be extended to all the south Asian countries
- Temperature, rainfall
- Quality surface observations are warranted

NCMRWF Extended Range Prediction System Multi-Scalar Drought[SPI] Outlook released on Jul 27, 2023



Future roadmap



Thanks

