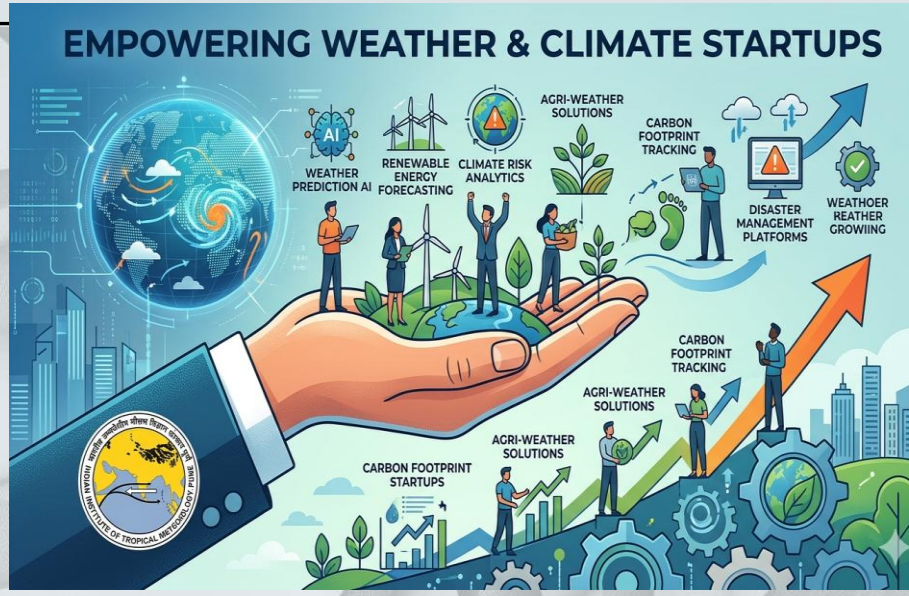
WEATHER AND CLIMATE STARTUPS

SUPPORTING THE BUSINESS ECOSYSTEM THROUGH EMERGING SCIENCE

OPPORTUNITIES AT MOES INSTITUTES



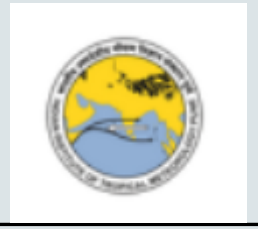
सत्यमेव जयते

Ministry of Earth Sciences

भारतीय उष्णदेशीय मौसम विज्ञान संस्थान, पुणे

INDIAN INSTITUTE OF TROPICAL METEOROLOGY, PUNE

MoES and Partner Institutions in the service to the Nation



MoES Data and Products

Level-1 data: Raw Weather and Climate forecast cum observation data

Level-2 data: Value Added Weather and Climate forecast and observation data

THE MOES ADVANTAGE

- ✓ In-house Model Development: Bharat Forecast System (across scales)
- ✓ Product Value Addition
- ✓ Sector-specific High Spatial and Temporal Resolution Data
- ✓ Data Customization
- ✓ AI Model-based Value Addition
- ✓ Regional Climate Change Projections
- ✓ Training and Software support for Climate data
- ✓ Online repositories for data

CORE DATA PRODUCTS

Focus Sector/Stakeholder	Product	Target
Agriculture	*(i) SPI/SPEI* *(ii) Smart Agro DSS* *(iii) Seasonal Forecast* *(iv) Daily to weekly Forecast*	*Drought management, Crop management and advisory, Crop insurance*
Hydrology	*(i) SPI/SPEI* *(ii) QPF* *(iii) Forecast Downscale*	*Estimate Irrigation requirement and flood forecast*
Health	*(i) Dengue Risk* *(ii) Heat Health Risk*	*Improve community health information system*
Rainfall Extremes	*(i) Nowcasting* *(ii) Short Range Forecasting*	*Urban flooding, aviation, flash flood*
Marine and Fisheries	*(i) Weekly forecast of Carbonaceous variable (pH, pCO2 etc)* *(ii) Fishery Population* *(iii) Fishery Climate Change Projection (Biomass, weight,location)*	*(i) Blue economy stakeholders* *(ii) Coastal fishery*

CORE DATA PRODUCTS

Focus Sector/Stakeholder	Product	Target
Energy	*(i) Forecast of Boundary Layer Variables, upper layer variables* *(ii) Wind and Solar Power Potential for next 10 years* *(iii) Site Suitability analysis for wind-farms* *(iv) Long term Climate Change projections*	*Renewable Energy sector, hyperlocal forecasts*
Finance	*(i) SPI/SPEI* *(ii) QPF* *(iii) Seasonal forecast* *(iv) Future climate projection*	*(i) Finance risk analysis* *(ii) Price Projection* *(iii) Inflation forecast*
Fog and Pollution	*(i) Fog forecast* *(ii) Pollution outlooks*	*(i) Health Sector* *(ii) Transport and Aviation*
Risk Dashboard	*(i) District Risk forecast based on temperature and precipitation*	*(i) Health Sector* *(ii) Disaster Management*
AI Weather Forecast (RAG Framework)	*(i) Multilingual Weather Forecast*	*(i) Chat and voice-based interface Forecast Applications for any sector*

Climate Data Source: IMD Observational and Operational Data

Climatological data from different 30 years period (latest one is based on 1991-2020)

i. Surface & Upper Air Climatology
ii. Severe Weather Hazards
iii. Disaster Weather Events Vulnerability Atlas
iv. Derived parameters (Hydrological, Aviation Met. Etc.)
v. Marine Climatology

1. Observational Data

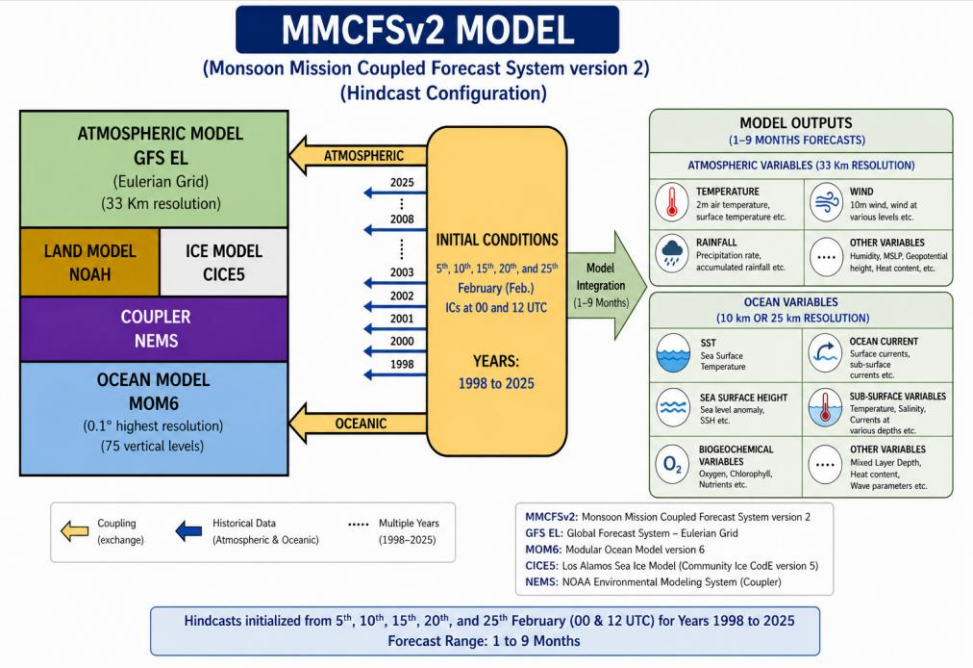
- i. Surface & Upper Air data (Point Data since 1901)
- ii. Gridded data: Rainfall: 0.25°, Temperature: 0.5°
- iii. Satellite Data (1983 onwards)
- iv. Radar Data (2002 onwards)
- v. Environmental data (2010 onwards)
- vi. Agrometeorological data (1945 onwards)
- vii. Aviation Met. Data
- viii. Marine Meteorological Data
- Ix. Astronomical data

2. Model Data: Real-time NWP model data from GFS, WRF, HRRR, E-WRF etc.

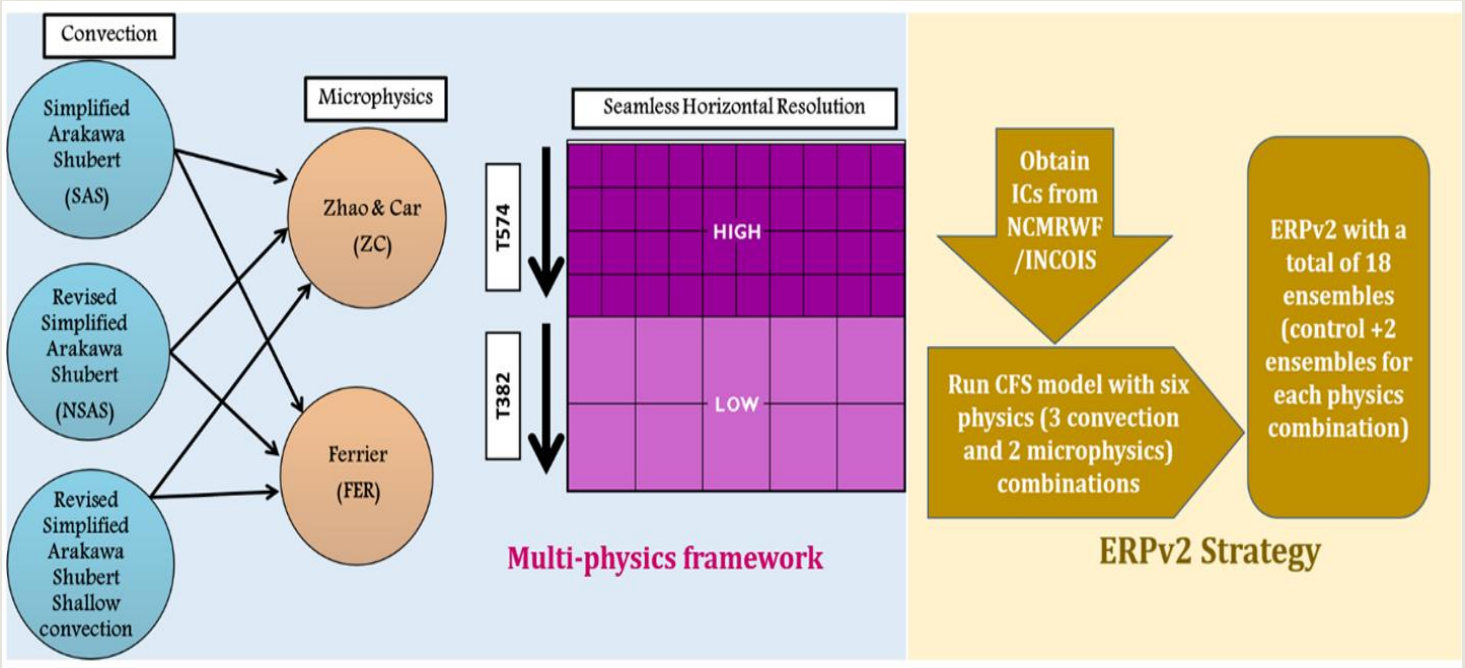
3. Operational Forecast Data since 1881

MOES CLIMATE MODELS

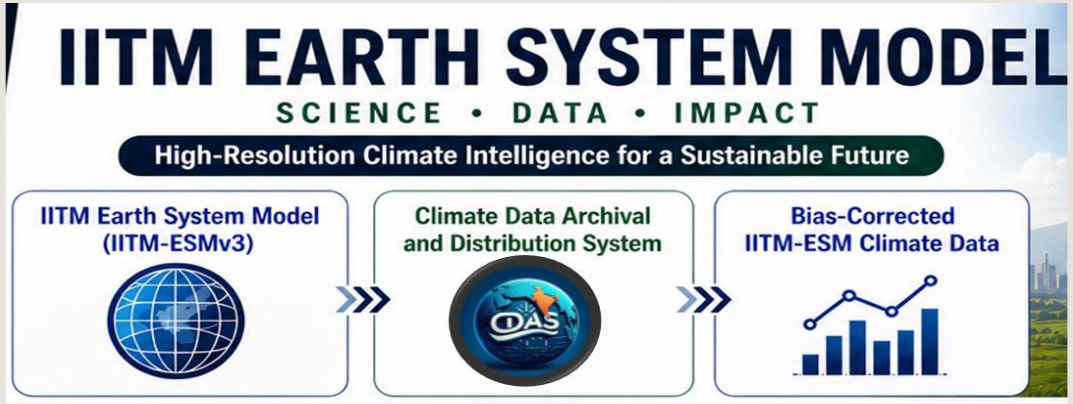
Seasonal Forecast (once every month)



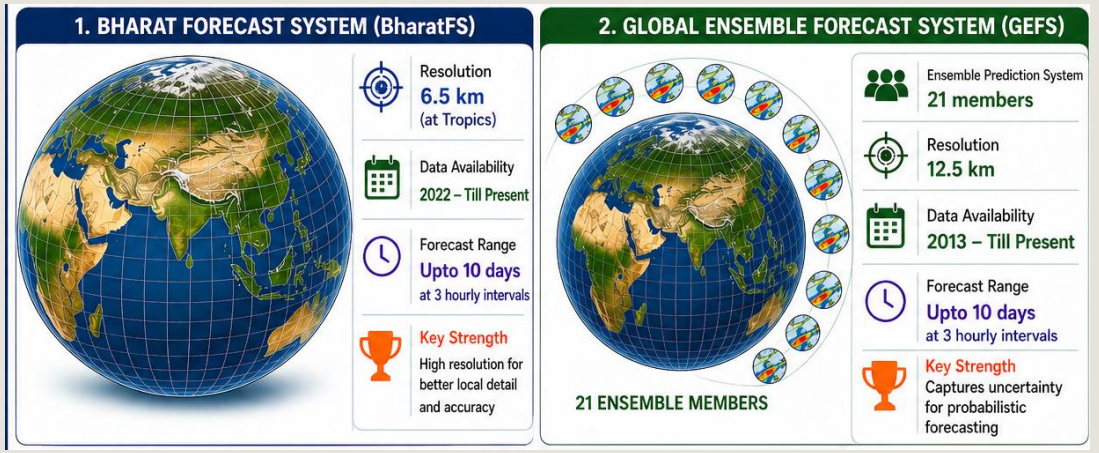
Subseasonal Weekly Forecast (once every week)



Climate Change Projection (CMIP protocol)



Short Range (less than a week forecast)



Seamless Modelling System

Integrates weather and climate predictions across multiple timescales and spatial resolutions

Global Deterministic Model

12 km resolution, 70 vertical levels, 10-day forecast (daily)

Regional Models

Focusing Indian subcontinent with 4 km (72 hrs. forecast) &1.5 km (48hrs. Forecast, winter) horizontal resolution

City-Scale Modeling

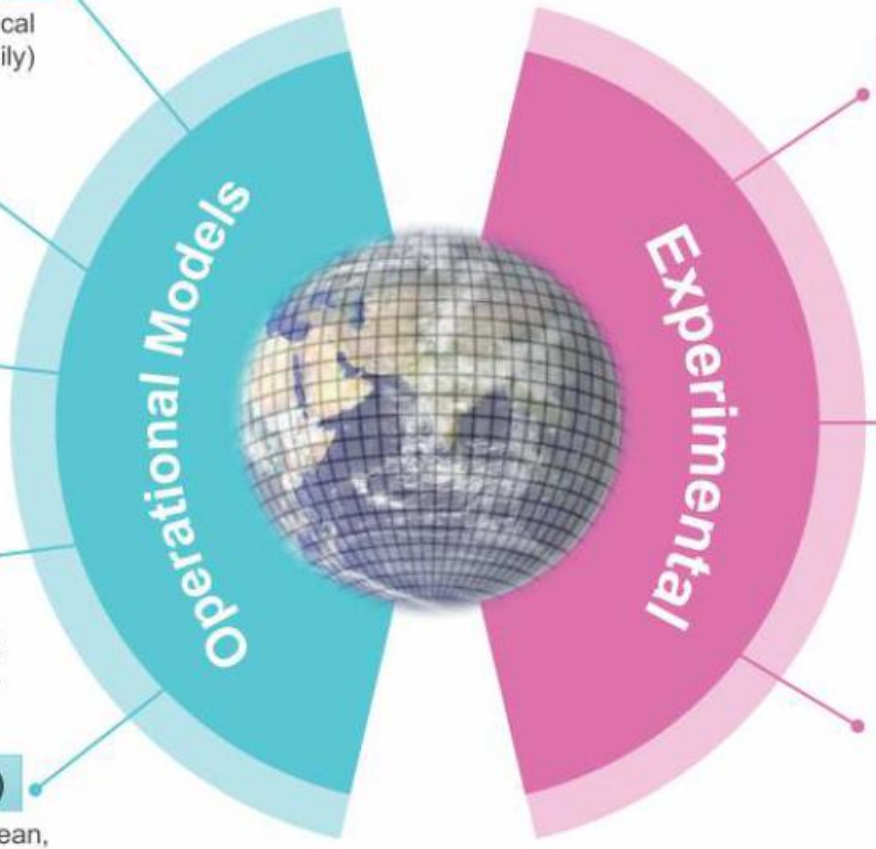
330m resolution, 48-hours forecast (winter), incorporating urban complexities for Delhi

Ensemble Prediction System

12km resolution, 22 perturbed ensembles 10-day forecast daily

Coupled Model(S2S)

Integrated atmosphere, land, ocean, and sea-ice models for subseasonal to seasonal forecasts(S2S)
Frequency: weekly & monthly
Forecast Length: 4- weeks (16 ENS) & 3-months(55 ENS)



Kilometre-Scale Modelling

Experimental 6km Global deterministic model, 5-day forecast, 70 vertical levels

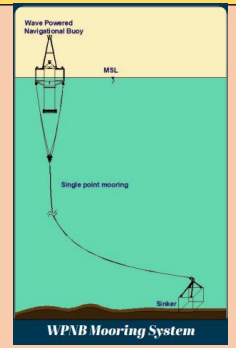
Regional Coupled NWP Model

Atmosphere (4km)
Ocean (2.2km)
Frequency: Daily
Forecast Length: 10 days

Global coupled NWP model

Atmosphere (10km)
Ocean (25km)
Frequency: Daily
Forecast Length: 5 days

Technologies Commercialized till 2026				
Sl.No	**Name of Know-How**	**Name of MSME/ Entreprenuers/ Start-ups**	**Brief Writeup**	**Schematic Representation**
1	Remotely Operated Vehicle	M/s Laursen & Toubro Limited	Remotely Operated Vehicle is used for offshore surveys conducted to study seabed conditions and marine resources including valuable minerals from the ocean floor and Gas hydrate surveys to identify methane hydrate deposits beneath the seabed.	
2	Robo Coastal Observer	M/s CT Control Technology (India) Pvt Ltd	NIOT has successfully design and developed Robo Coastal Observer (RCO) for real time data measurements of oceanographic and meteorological parameters. RCO is a self-propelled aquatic device that can be used for lake, river, coastal and deep sea surveillance purposes. It can also be used to rescue a person who has fallen overboard.	
3	Wireless Expandable Bathythermograph Conductivity Temperature and Depth Profile	M/s. Azista Industries Pvt. Ltd	A compact ocean profiling system designed to measure conductivity, temperature, and depth parameters in marine environments. The system enables rapid acquisition of vertical ocean profiles for scientific and operational studies. It supports ocean	

Sl.No	Name of Know-How	Name of MSME/ Entreprenuers/ Start-ups	Brief Writeup	Schematic Representation
4	Wave Powered Navigational Buoy	M/s Sangir Plastics Pvt Ltd,Gujarat	Power extraction based on the Oscillating Water Column (OWC) principle using wave energy. Currently under operation at Kamarajar Port Ltd, Chennai and oceanographic data and buoy's location are transmitted every hour to port authorities and other users	
5	Multiplex PCR Detection Kit for detecting virulent genes of Enterococcus faecal in water and seafood (MPCR)	M/s Saai Electro Biogenic India Pvt Ltd,Chennai	NIOT-E. faecalis Multiplex PCR master mix for the specified amplification and detection of virulent genes. Positive and negative PCR control mix helps to identify and interpret the virulence range of the pathogen.	
6	Process for the production of Lutein from Marine Microalgae	M/s Vectrogen Biologicals Pvt Ltd, Hyderabad	Lutein is a vital macular pigment in the retina of eye and protects the eye from the ionizing effect of blue light. It is essential for protecting the cellular components of the vital organs from oxidative damage.	

NCPOR:OBSERVATIONS IN POLAR REGIONS

Research Stations

Antarctica
Maitri, Bharati- Occupied year round - Winter capacity - ~25 each station

Arctic
Himadri – Occupied Year round, winter capacity ~ 4

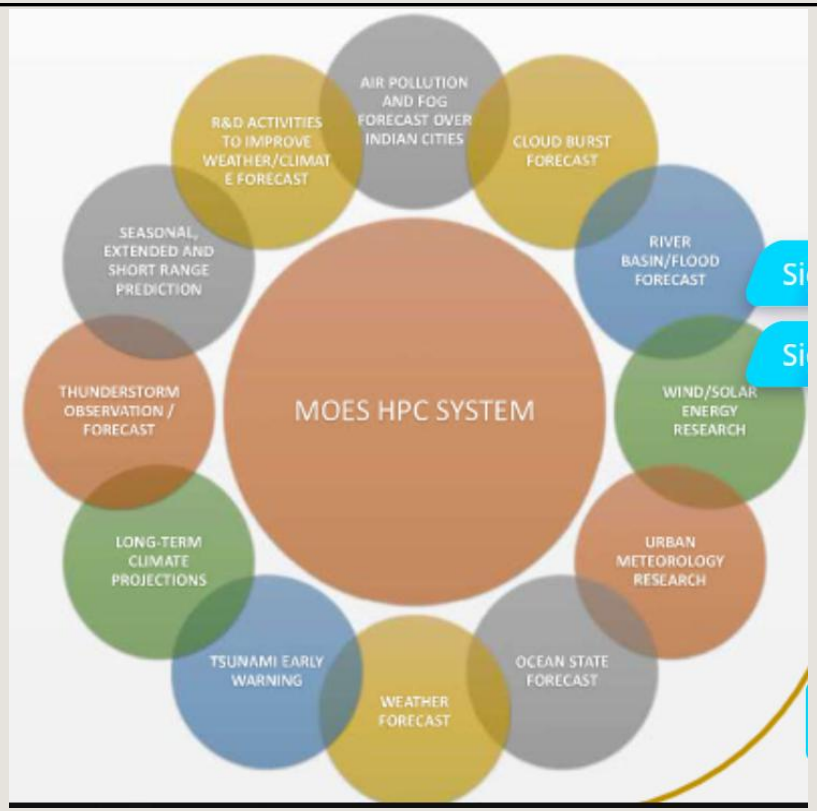
Himalaya
Himansh- Occupied during summer

All climate variables. Surface to upper atmosphere.

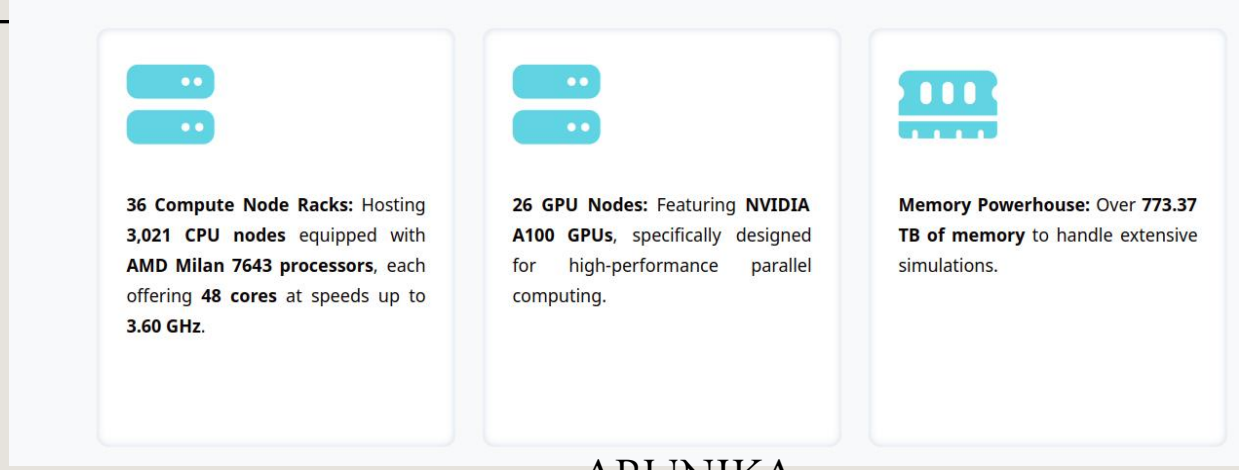
Oceanographic measurements - Physical, Biological, chemical, Sea-ice

With excellent communication facilities back to India

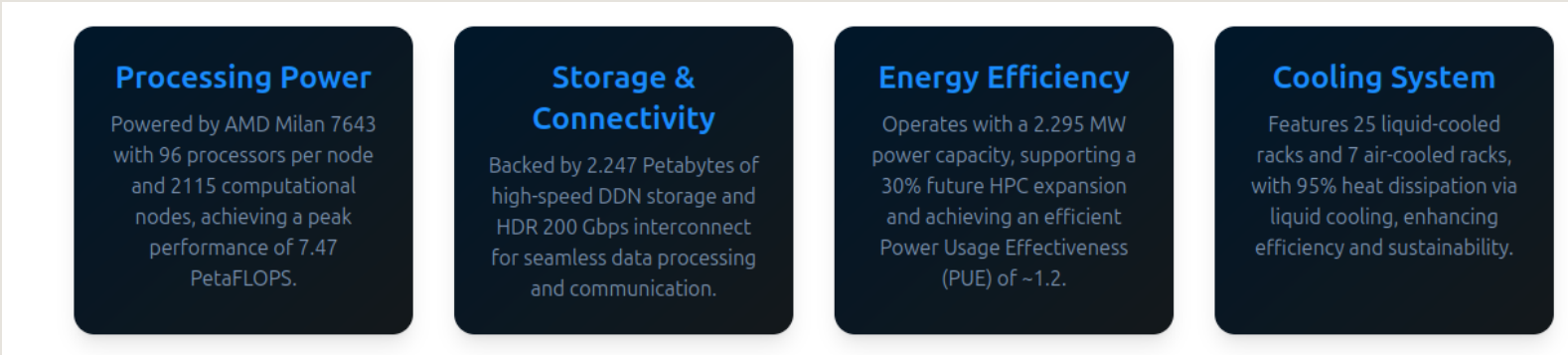
THE ARKA AND ARUNIKA HPC



ARKA



ARUNIKA



https://arka.tropmet.res.in/Arka/introduction.html
https://nwp.ncmrwf.gov.in/computing/hpc-systems

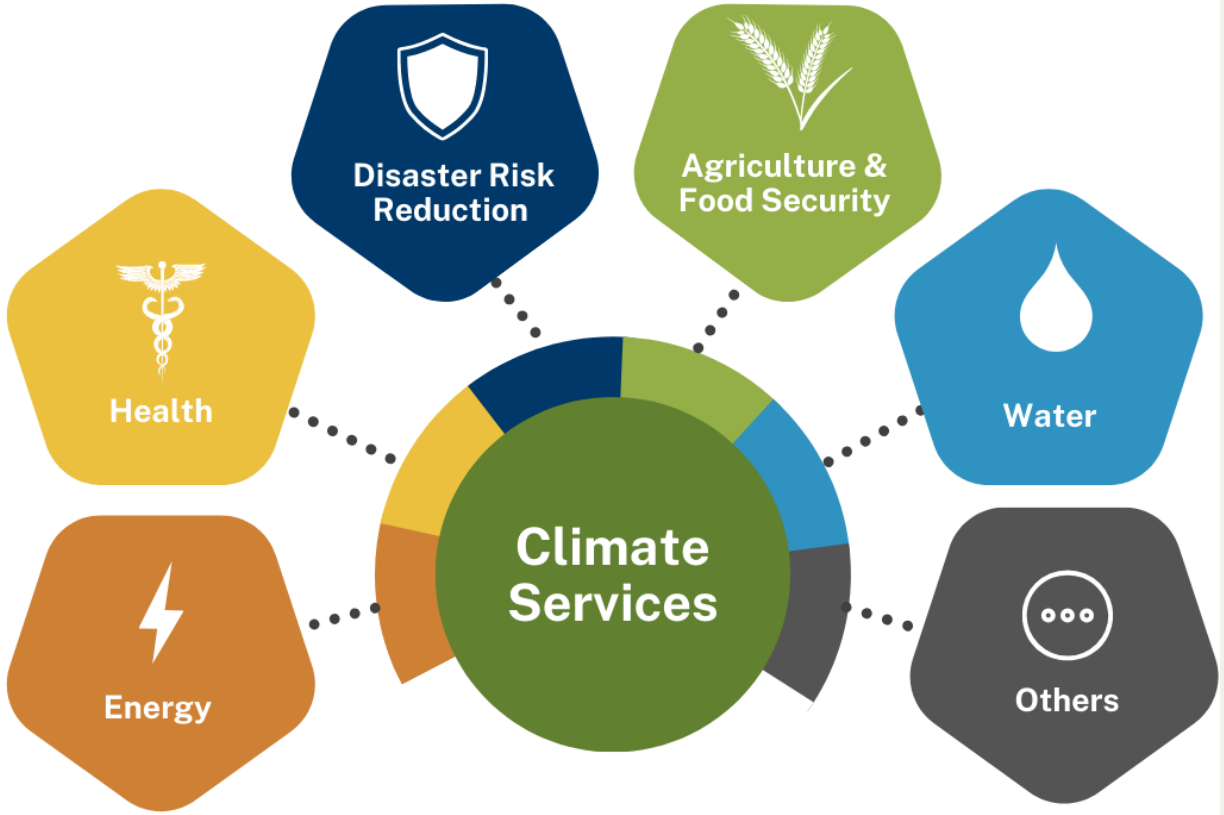
Peak Performance of 11.77PF and dedicated 1.9PF for Artificial Intelligence research

- Enabled operational 6.5km Bharat Forecast System
- Enabled regional simulations at sub-km scales

PRODUCT DETAILS

https://www.linkedin.com/pulse/get-ready-set-go-bryan-yager/

three-stage approach focused on preparation, organization, aand immediate execution for different sectors



National Framework for Climate Services for India

(NFCS - INDIA)

IITM EARTH SYSTEM MODEL

Climate Modeling Group
Centre for Climate Change Research, IITM

CCCR

SCIENCE • DATA • IMPACT

High-Resolution Climate Intelligence for a Sustainable Future

- High-Resolution Modeling
- Participated in Climate Model Intercomparison Project (CMIP6)
- India's First Homegrown Climate Model to Contribute to the IPCC AR6.

IITM Earth System Model (IITM-ESMv3) → **Climate Data Archival and Distribution System** → **Bias-Corrected IITM-ESM Climate Data**

APPLICATIONS ACROSS SECTORS

Renewable Energy | Agriculture | Finance | Blue Economy | Climate Risk | Health

KEY STAKEHOLDERS

- National Adaptation Plan for India (MoEFCC)
- Biennial Transparency Report for India (MoEFCC)
- TamilNadu State Action Plan
- Kalpasar Dam — Govt. of Gujarat
- Reserve Bank of India

BIAS CORRECTED PRODUCT FROM IITM

Period	1950–2100 (for 3 SSP scenarios)
Resolution	25 kms
Frequency	Daily and Monthly
Products	• **Heat Stress (Ready)** • **Climate Extreme Indices** (Under preparation)

BIAS CORRECTED DOWNSCALED CLIMATE PROJECTIONS
from IITM-ESM and other CMIP6 models

Data may be obtained from below links :

IITM-ESM CMIP6 :
https://esg-cccr.tropmet.res.in/thredds/catalog/esg_dataroot6/catalog.html

CORDEX (for South Asia) :
https://cccr.tropmet.res.in/cordex-sa/cordexsa-data.php

SCAN TO ACCESS DATA

FROM CLIMATE SCIENCE TO REAL-WORLD SOLUTIONS

High Resolution (25 km) | Long-term Projections 1950–2100 | Bias Corrected & Reliable | Open Access & Scalable | Enabling Resilient Communities & Economies

BETTER DATA. BETTER DECISIONS. BETTER FUTURE.

Decadal Prediction of Climate Extremes

Bias-corrected and downscaled extreme rainfall datasets, developed using Empirical Quantile Mapping, are available from IITM DCPS and CMIP6 DCPP.

IITM DCPS provides the decadal prediction up to 2035. These datasets span lead times from 1 to 10 years, enabling improved decadal-scale prediction of extreme rainfall events.

Products will be provided for lead-1 year, 2-5 year lead and 6-10 year lead.

Decadal Probabilistic Prediction Products

- **Agroclimatic Indices**
- **Extreme Temperature Events**
- **Extreme Rainfall Events**
- **Sea Level Rise**
- **Wind and Solar Power Potential**

Application Areas for Agroclimate Indices

Decadal prediction of :

- Consecutive Dry Days (CDDs)
- Consecutive Wet Days (CWDs)

Supports:

- Crop risk assessment
- planning crop selection, variety choice, or planting calendars
- Water resource/ Irrigation management

Application Areas for Heatwave/coldwave indices

Decadal Prediction of:

- Temperature extremes (Tmax / Tmin extremes)
- Seasonal and interannual variability
- Heat/cold stress conditions

Supports:

- Climate risk assessment
- Agricultural planning (crop sensitivity to temperature)
- Energy demand forecasting (heating/cooling)

Application Areas for Sea Level indices

- Coastal Planning & Urban Development
- Coastal ecosystem management
- Disaster Risk Management
- Climate Change research & Policy

Application Areas of Rainfall Indices

Decadal prediction of :

- Extreme rainfall events
- Flood risk assessment
- Monsoon variability and shifts

Supports:

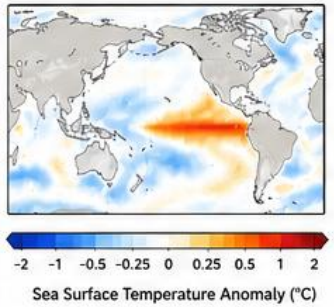
- Climate risk planning
- Infrastructure resilience
- Water resource management

MMCFSv2 MODEL: PRODUCTS / APPLICATIONS

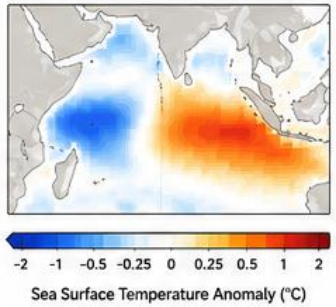
Actionable Climate Information for Society and Sectoral Decision Making

1 Seasonal Outlook of ENSO, IOD

ENSO Outlook (SST Anomaly)

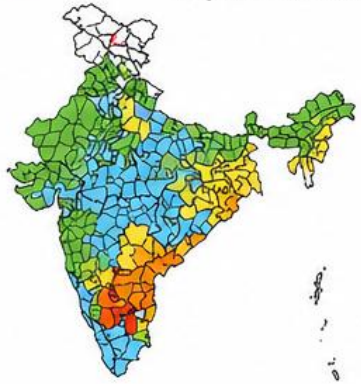


IOD Outlook (SST Anomaly)



Predictive outlook of El Niño / La Niña and Indian Ocean Dipole events

2 Seasonal Outlook of Monsoon Rainfall (upto district level)



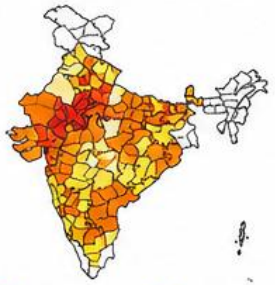
Rainfall Outlook (% of LPA)

- Large Excess (≥60%)
- Excess (20% to 59%)
- Normal (-19% to +19%)
- Deficient (-59% to -20%)
- Large Deficient (-99% to -60%)

District-level probability forecast of monsoon rainfall categories

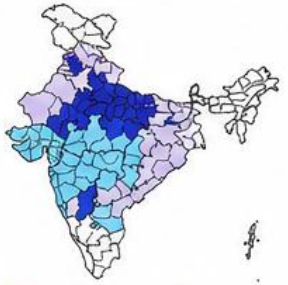
3 Seasonal Outlook of Heat and Cold Waves (upto district level)

Heat Wave Outlook



High Low Moderate No Signal

Cold Wave Outlook



High Low Moderate No Signal

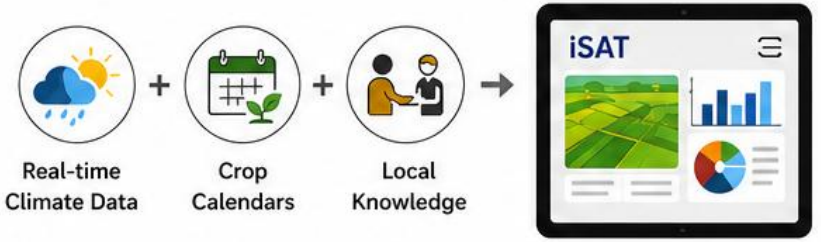
District-level probability forecast of heat wave and cold wave events

4 Location-specific Weather Forecasts and Agricultural Advisories in Local Language through Meghdoot App

- आपके स्थान के लिए मौसम पूर्वानुमान
- फसल सलाह
- कीट एवं रोग प्रबंधन सलाह
- स्थानीय भाषा में जानकारी

5 Intelligent Agricultural Systems Advisory Tool (iSAT)

By integrating real-time climate data, crop calendars, and local knowledge, ISAT addresses the gap in timely and actionable decision support for smallholder farmers.



Real-time Climate Data + Crop Calendars + Local Knowledge →

- ✓ Crop Planning
- ✓ Irrigation Advisory
- ✓ Pest & Disease Management
- ✓ Risk Assessment
- ✓ Informed Decision Making

Timely, location-specific, and actionable advisories for improved farm productivity and resilience

LPA: Long Period Average (typically based on 30 years of data)

Rainfall Categories: Large Excess (≥60%), Excess (20% to 59%), Normal (-19% to +19%), **Deficient** (-59% to -20%), Large Deficient (-99% to -60%) of LPA

APPLICATIONS OF SEASONAL PREDICTION SYSTEM

From Forecasts to Impact-based Decisions

INPUTS TO FORECAST SYSTEM

- Ocean–Atmosphere Observations
- Sea Surface Temperature (SST)
- Climate Modes (ENSO, IOD, MJO)
- Land Surface Conditions
- Historical Data & Models

IITM's SEASONAL PREDICTION SYSTEM

(Indian Institute of Tropical Meteorology, Pune)

- High Performance Computing
- Coupled Ocean–Atmosphere Climate Models
- Advanced Data Assimilation & Model Initialization

FORECAST OUTPUTS (1 to 9 MONTHS)

- TEMPERATURE FORECASTS
- RAINFALL FORECASTS
- SST FORECASTS

1. AGRICULTURE & FOOD SECURITY

APPLICATIONS

- Sowing time & crop planning
- Irrigation scheduling
- Drought preparedness
- Pest & disease management
- Yield forecasting

STAKEHOLDERS

Farmers; Agri Ministries; Agri Input Companies; Food Supply Managers

2. WATER RESOURCE MANAGEMENT

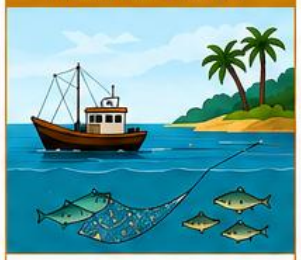
APPLICATIONS

- Reservoir inflow forecast
- Water allocation
- Flood risk management
- Drought management
- Groundwater recharge planning

STAKEHOLDERS

Reservoir Managers; Irrigation Departments; Urban Water Utilities; River Basin Authorities

3. FISHERIES & MARINE SECTOR



APPLICATIONS

- Fish abundance & migration
- Upwelling zone prediction
- Harmful algal bloom alerts
- Coral bleaching alerts
- Cyclone risk over oceans

STAKEHOLDERS

Fishermen; Aquaculture Operators; Marine Departments; Coastal Communities

4. PUBLIC HEALTH

APPLICATIONS

- Heatwave preparedness
- Vector-borne disease risk (malaria, dengue)
- Water-borne disease risk
- Seasonal malnutrition planning

STAKEHOLDERS

Health Ministries; Disease Control Agencies; NGOs; Urban Administrations

5. DISASTER RISK REDUCTION

APPLICATIONS

- Flood outlook & early warning
- Drought early warning
- Cyclone season outlook
- Landslide & wildfire risk
- Early response planning

STAKEHOLDERS

Disaster Management Agencies; Emergency Response Teams; Infrastructure Planners; Insurance Sector

6. ENERGY SECTOR

APPLICATIONS

- Electricity demand forecasting
- Hydropower generation planning
- Renewable energy forecasting
- Fuel & gas demand planning
- Grid load management

STAKEHOLDERS

Power Utilities; Renewable Operators; Grid Managers; Oil & Gas Companies

7. INSURANCE & FINANCE

APPLICATIONS

- Weather-index insurance
- Crop loss risk assessment
- Commodity price forecasting
- Loan & credit risk planning
- Climate risk analysis

STAKEHOLDERS

Insurers; Banks; Investors; Govt. & Policy Makers

OUTCOMES & BENEFITS

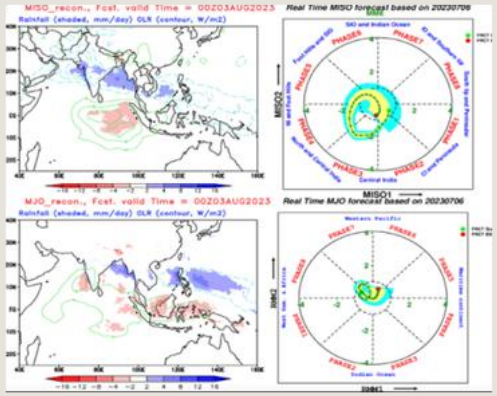
- Reduced Risks
- Better Planning & Resource Management
- Improved Livelihoods & Food Security
- Economic Savings & Growth
- Sustainable Development & Climate Resilience
- Better Decisions for a Resilient Future

Weekly Forecast Based Products

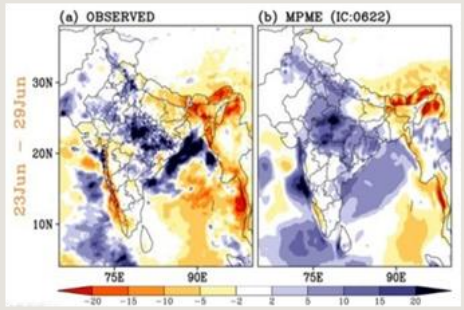
Real-time Forecast Products:

2-3 weeks lead-time forecasts (daily as well as weekly) of Rainfall, winds, temperature, soil moisture, humidity, SPI/SPEI, large scale indices of intraseasonal oscillations, etc.

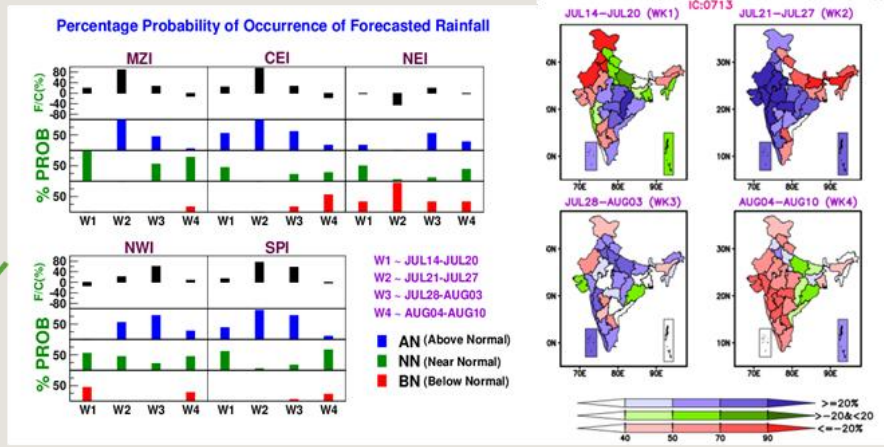
Monsoon ISO : MJO & MISO



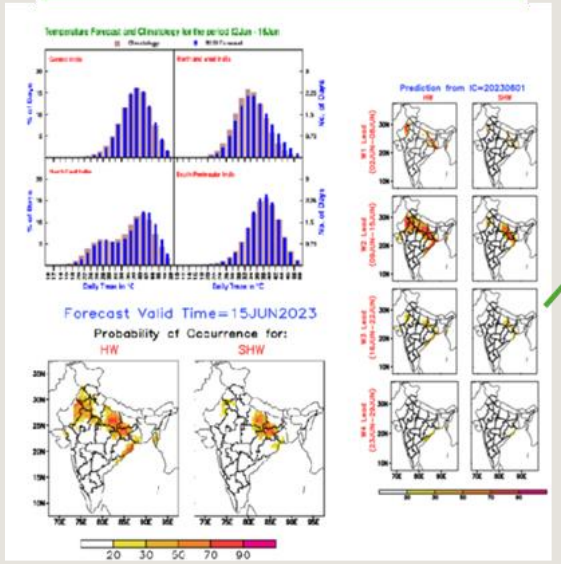
Heavy Rainfall



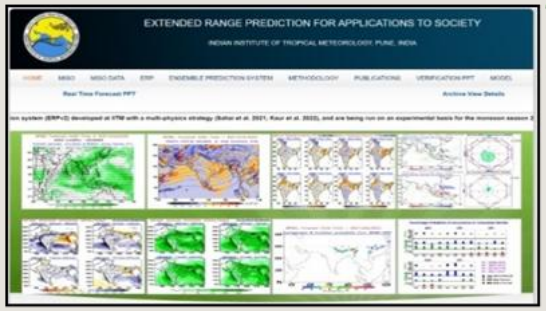
Probabilistic Forecast of Rainfall



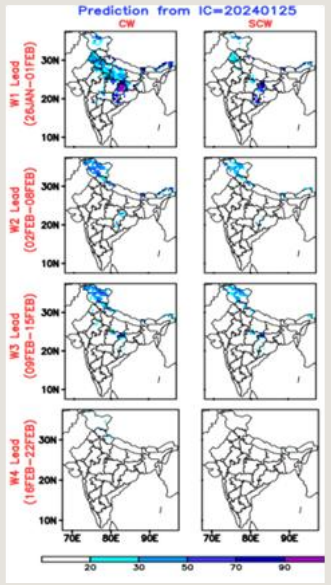
Heat Waves

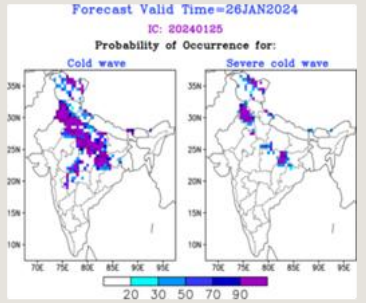


http://www.tropmet.res.in/erpas/

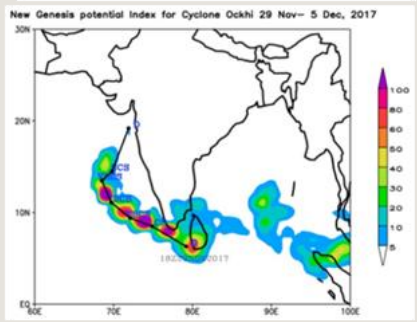


Cold Waves





Cyclones



SPI/SPEI

Operational Drought Forecasting Products (ERP)

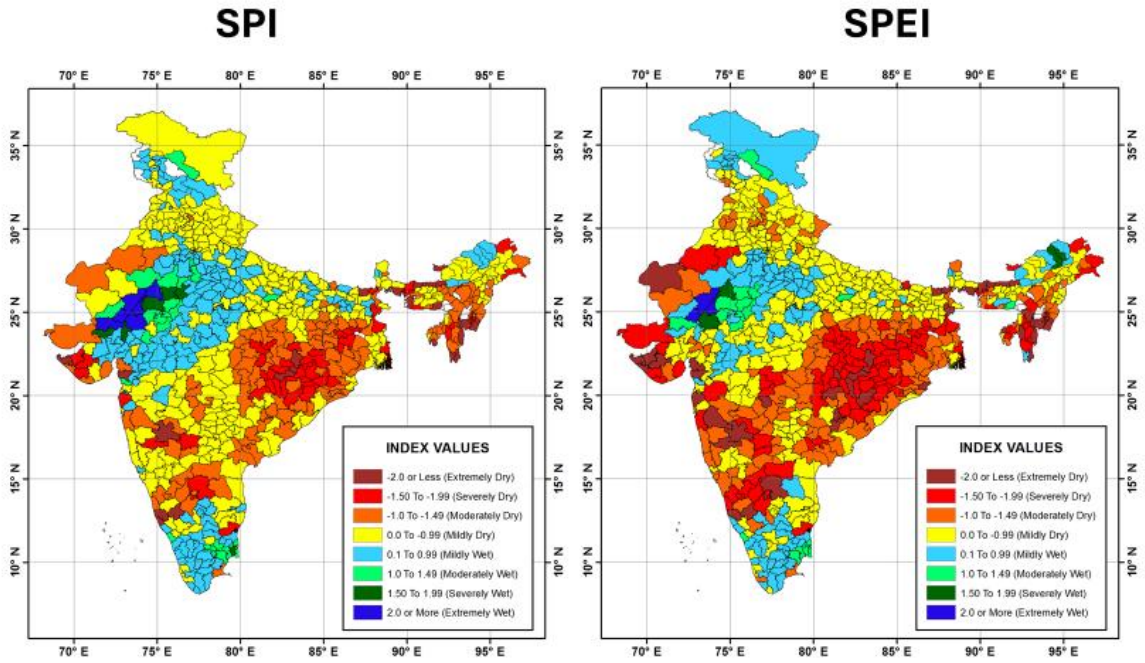
Product
Extended Range Forecast of Drought Condition

Deliverable
Gridded SPI & SPEI
District SPI & SPEI

Resolution
1 to 4 Weeks
India
Weekly-Updates

Status
Gridded product ready
District Forecast under development

Drought Outlook for Coming Four Weeks (5 Jan – 2 Feb 2023)



Standardized Precipitation Index (SPI): A tool based solely on cumulative probability of precipitation, used to monitor drought by determining the rarity of wet or dry conditions across different time scales.

Standardized Precipitation Evapotranspiration Index (SPEI): A multi-scalar drought index that quantifies drought severity by analysing the balance between precipitation and potential evapotranspiration (PET), identifying wet and dry events.

SHORT AND MEDIUM RANGE FORECAST SYSTEM

1. BHARAT FORECAST SYSTEM (BharatFS)

Resolution
6.5 km
(at Tropics)

Data Availability
2022 – Till Present

Forecast Range
Upto 10 days
at 3 hourly intervals

Key Strength
High resolution for better local detail and accuracy

2. GLOBAL ENSEMBLE FORECAST SYSTEM (GEFS)

21 ENSEMBLE MEMBERS

Ensemble Prediction System
21 members

Resolution
12.5 km

Data Availability
2013 – Till Present

Forecast Range
Upto 10 days
at 3 hourly intervals

Key Strength
Captures uncertainty for probabilistic forecasting

GEFS: ADDITIONAL PROBABILISTIC PRODUCTS

- Probabilistic Forecast of Extreme Rainfall
- Probabilistic Tropical Cyclone Forecast
- Extreme Rainfall Forecast based on Percentiles Probabilities **(P90, P95 only)**
- Extreme Forecast Index (EFI)

COMMON AVAILABLE VARIABLES

- Rainfall
- Temperature (Tmin, Tmax, T2m, Dew Point)
- Relative Humidity (RH)
- Wind (u, v components)
- Surface Water Runoff
- Mean Sea Level Pressure (MSLP)
- Total Cloud Cover
- Soil Moisture
- RH and many more

BharatFS → High Resolution (6.5 km)
Better local accuracy for detailed forecasts

भारत पूर्वानुमान प्रणाली
BHARAT FORECAST SYSTEM

GEFS → Ensemble (21 members)
Better uncertainty estimation and probabilistic extreme event forecasting

TOGETHER → RELIABLE, DETAILED & PROBABILISTIC FORECASTS

UP TO 10 DAYS AT 3 HOURLY INTERVALS

SECTOR-SPECIFIC APPLICATIONS OF SHORT AND MEDIUM RANGE FORECAST PRODUCTS

1–10 DAYS — Timely Forecasts. Better Decisions. Safer Tomorrow.

AGRICULTURE

- Crop planning (sowing, irrigation, harvesting)
- Pest and disease management
- Protection from extreme events (rain, heatwaves, frost)

AVIATION

- Flight scheduling and route optimization
- Turbulence and storm avoidance
- Improved passenger safety and fuel efficiency

MARINE & FISHERIES

- Safe navigation and fishing zone advisories
- Cyclone and high-wave warnings
- Harbor and offshore operation planning

ENERGY SECTOR

- Demand forecasting (temperature-driven consumption)
- Renewable energy optimization (solar, wind forecasting)
- Grid stability and outage prevention

URBAN PLANNING & DISASTER MANAGEMENT

- Early warning for floods, heatwaves, heavy rain
- Landslide & forest fire early alerts
- Emergency preparedness and evacuation planning
- Traffic and drainage management

TRANSPORTATION & LOGISTICS

- Route planning and delay minimization
- Supply chain efficiency
- Safety in road, rail, and shipping operations

PUBLIC HEALTH

- Heatwave/cold wave alerts
- Resource allocation (ambulances, hospitals)

ECONOMIC & BUSINESS ACTIVITIES

- Retail demand forecasting (weather-dependent sales)
- Event planning and tourism management
- Insurance risk assessment

LANDSLIDE RISK MANAGEMENT

- Heavy rainfall warnings for landslide susceptible areas
- Early alerts for local authorities and communities
- Support for road and infrastructure safety

FOREST FIRE MANAGEMENT

- Forecast of high fire danger conditions (heat, low humidity, winds)
- Early warnings for fire prevention and suppression planning
- Resource deployment optimization

QUICK COMMERCE & LAST MILE DELIVERY

- Real-time planning for order fulfillment
- Route optimization and delivery time accuracy
- Inventory stocking based on expected weather impact
- Ensuring rider safety during adverse weather

KEY TAKEAWAY

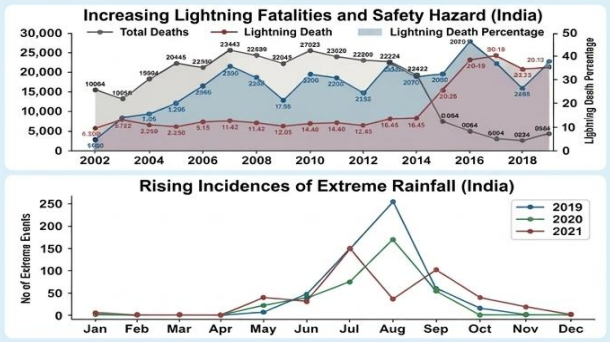
Short and medium range (1–10 days) forecast products provide actionable insights that enable **timely action**, **reduce losses**, and **enhance safety and resilience** across all sectors.

Timely Action | Risk Reduction | Cost Savings | Better Planning & Efficiency | Enhanced Safety & Resilience | Sustainable Development

Very short-range prediction and Nowcast

The Challenge

WEATHER CHALLENGE



Lightning + Extreme Rainfall

- Thousands of deaths annually
- Urban flooding & infrastructure damage
- Severe weather uncertainty

BUSINESS IMPACT

No Hyperlocal Alerts → Business Loss

- Revenue loss
- Worker safety risks
- Operational delays

Our Solution

Hazard Prediction System

Model description and product generation workflow

1 INPUTS / FORCING

Inputs and Initial Conditions

- BFS (Bharat Forecast System) IC/BC
- Native resolution: 6 × 6 km
- Large-scale atmospheric forcing for dynamical downscaling
- Operational meteorological fields and boundary conditions

Pan-India forecasting support

2 WRF MODEL CORE

WRF-ARW Core Model

- Advanced Research WRF, non-hydrostatic, fully compressible
- Eulerian mass dynamical core
- Terrain-following hydrostatic pressure coordinate
- Arakawa-C horizontal grid

Physics configuration

- PBL: Yonsei University (YSU)
- Radiation: RRTMG shortwave & longwave
- Surface layer: revised MM5 Monin-Obukhov
- Land surface: Unified Noah LSM

3 IITM IN-HOUSE DEVELOPMENT / DYNAMICAL DOWNSCALING

IITM in-house model development

- Dynamical downscaling
- Operational 3 km forecast
- Experimental / hyperlocal 1 km + 300 m forecast
- Improved microphysics scheme
- Improved aerosol / CCN concentration treatment
- Enhanced thunderstorm and lightning diagnostics

Nested high-resolution domains

Bharat Forecast System (BFS) 6 km → WRF 3 km → WRF 1 km → WRF 300 m

3 km lead time: ~12 h to 1 day (12 UTC cycle)
1 km + 300 m lead time: ~3 h

4 OFFLINE LIGHTNING INDICATORS

Offline lightning indicators tested from model output

1. Maximum Vertical Velocity (Wmax) based on storm updraft strength
2. Lightning Potential Index (LPI) based on storm electrification potential
3. Updraft Volume > 5 m/s based on the volume of strong upward motion
4. Updraft Volume > 10 m/s based on the volume of intense upward motion
5. Ice Water Path (IWP) based on total ice content in the cloud column
6. 35 dBZ Echo Volume based on the storm volume with high radar reflectivity
7. Graupel Echo Volume based on graupel-rich storm volume

5 OPERATIONAL PRODUCTS

- Hourly Rainfall Threat
- Lightning Flash Threat
- Maximum Reflectivity (Max dBZ)

Additional visual products

Rainfall GIF | Lightning GIF | Lightning variability

Primary stakeholders

- NDMA / SDMA
- Aviation
- Service sector / delivery partners
- Energy sector
- Academia & research

TS-Lightning Modeling Team, Monsoon Mission, IITM Pune

Severe Convective Weather Threat: Very short-range Prediction & Nowcast

Product

Very Short-Range Prediction and Nowcasting

Deliverable

Lightning-Threat

Impact-based rainfall threat

Model

Resolution

3 km / 2 km for Pan India

300 m for City-based/ hyper-local

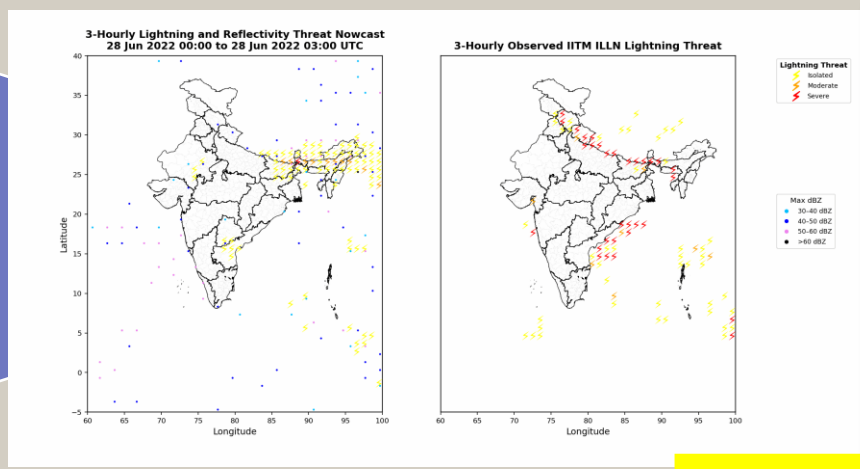
Daily-updates

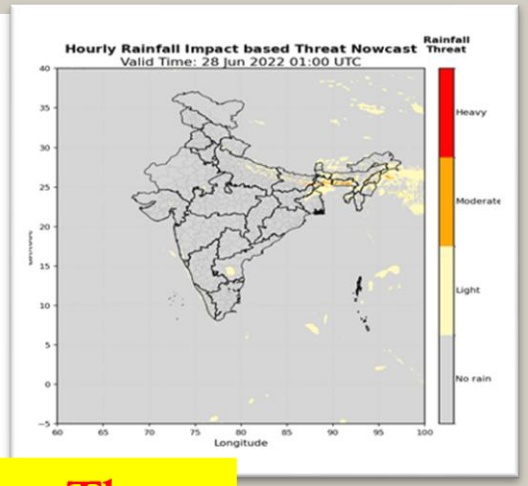
Status

Gridded product ready for district and block level.

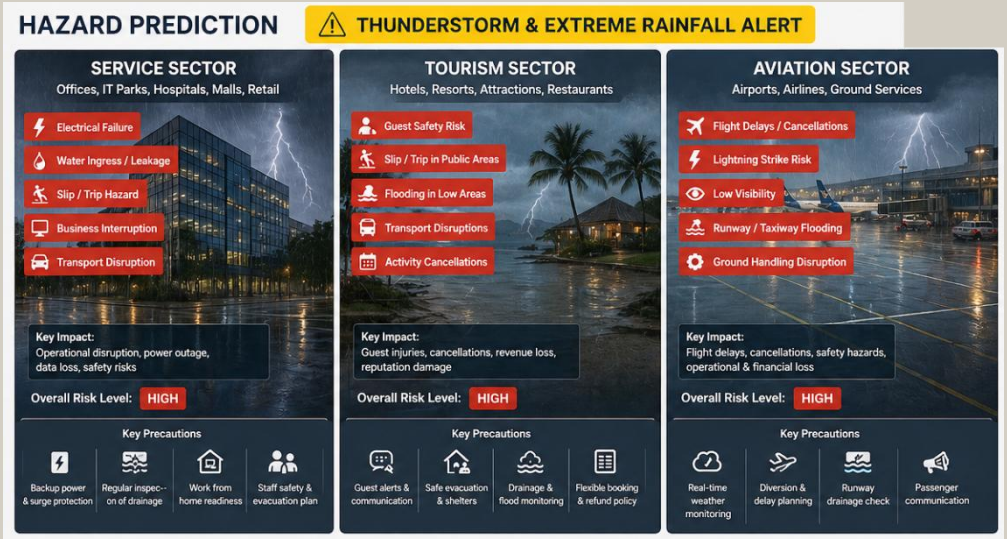
Lead Time:

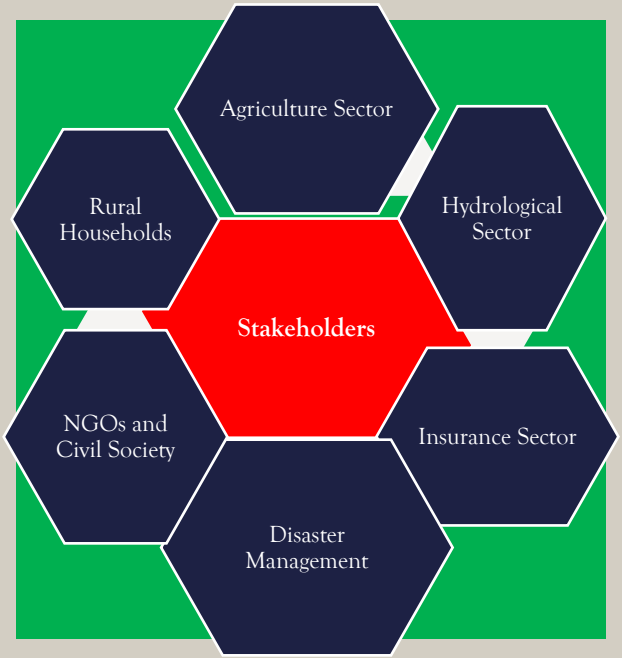
3 to 12 hours

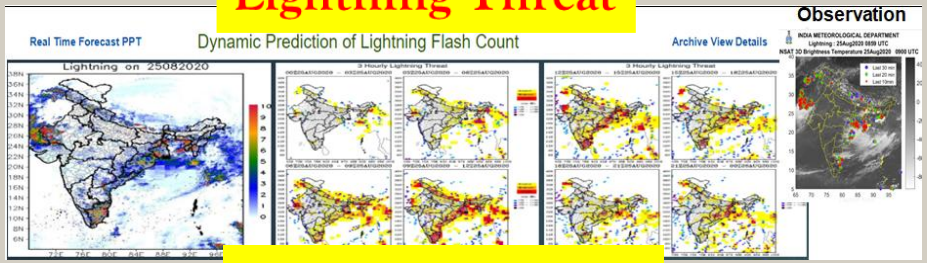




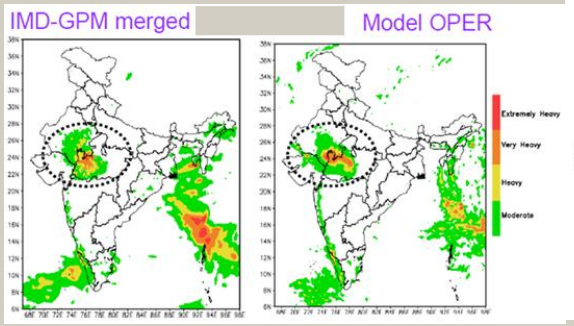
Lightning Threat

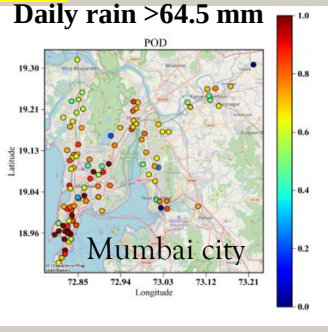




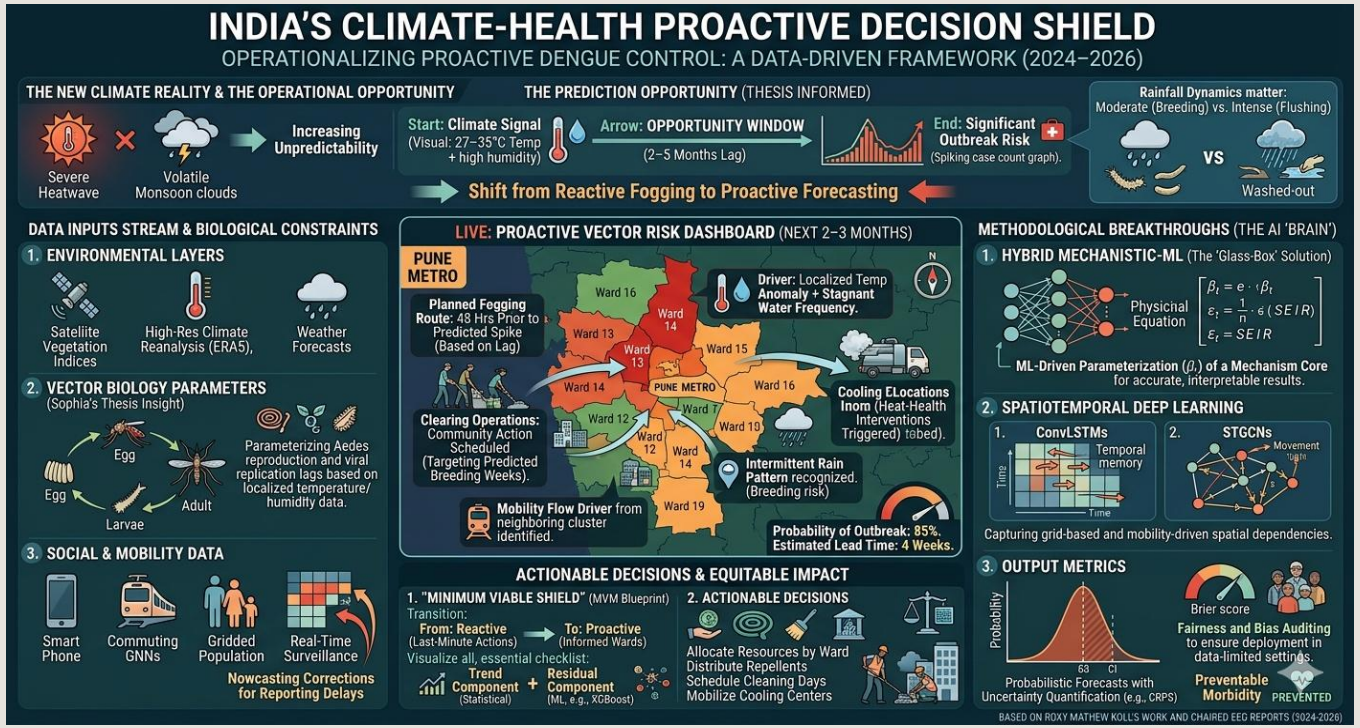


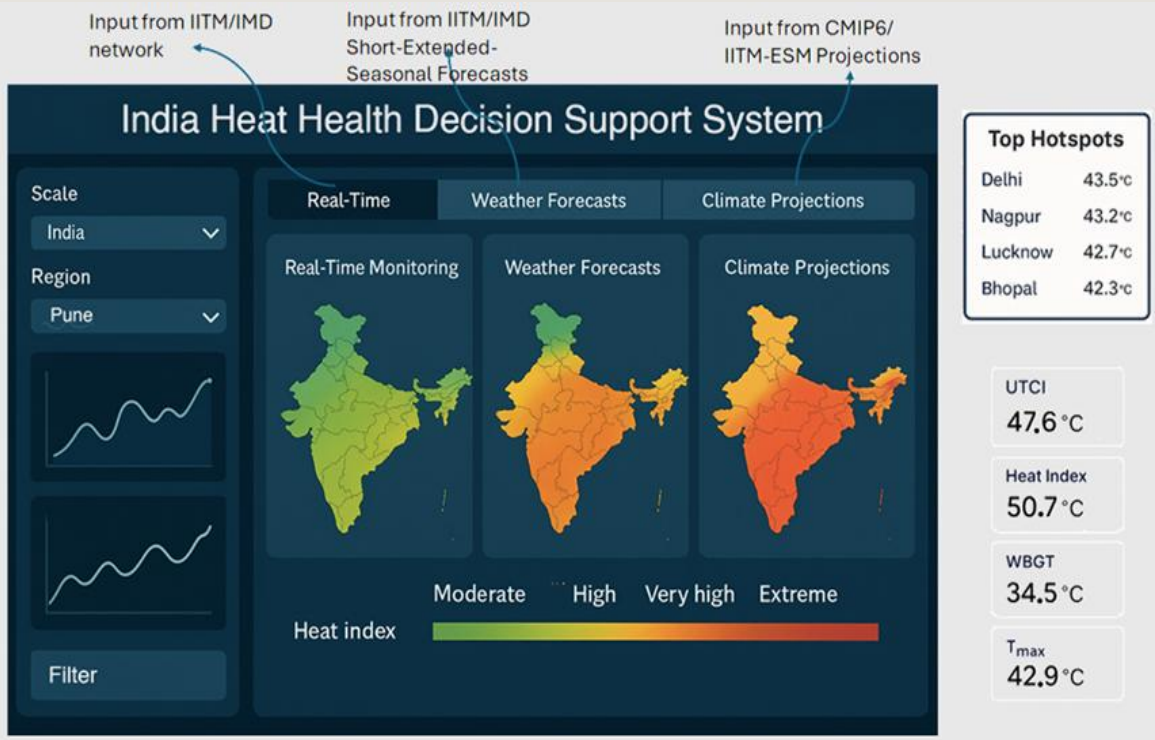
Rainfall Threat





Health Climate Applications





BIAS CORRECTED PRODUCT FROM IITM

Period	1950–2100 (for 3 SSP scenarios)
Resolution	25 kms
Frequency	Daily and Monthly
Products	• Heat Stress (Ready) • Climate Extreme Indices (Under preparation)

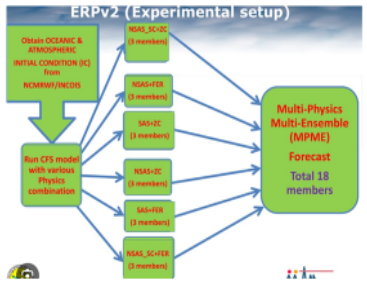
Fisheries Product

Product
Extended-Range Forecast of Carbonaceous Variables

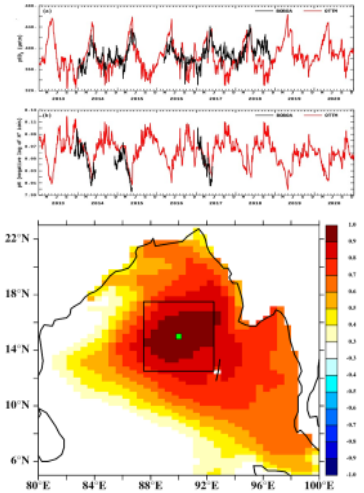
Deliverable
pCO2
pH
CO2 flux
Ω_{arg}
Ω_{Cal}

Resolution
30-day
Global
Weekly-Update

Status
Hindcasts Ready.
Forecasts under development.



OTTM BGC MODEL



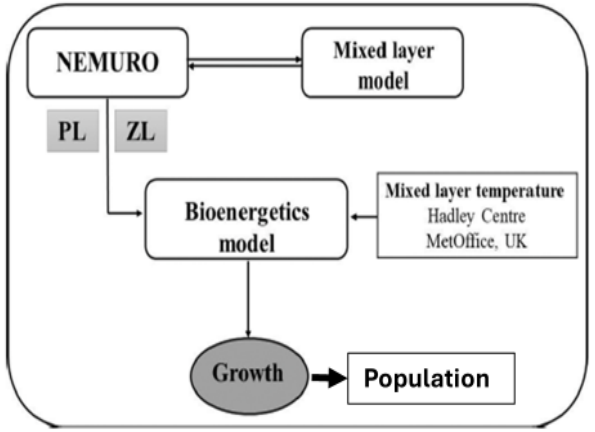
Product
Fishery-Population
Sardines
Mackerel
Anchovies

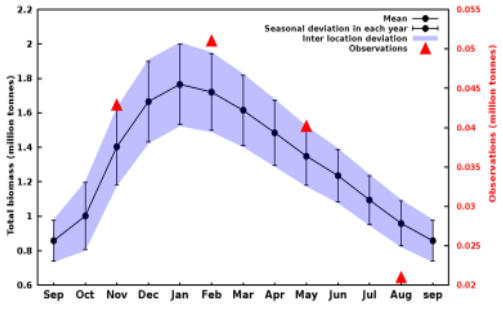
Deliverable
Biomass
Weights
Location

Resolution
Fishing Grounds of Indian EEZ
30-day outlook

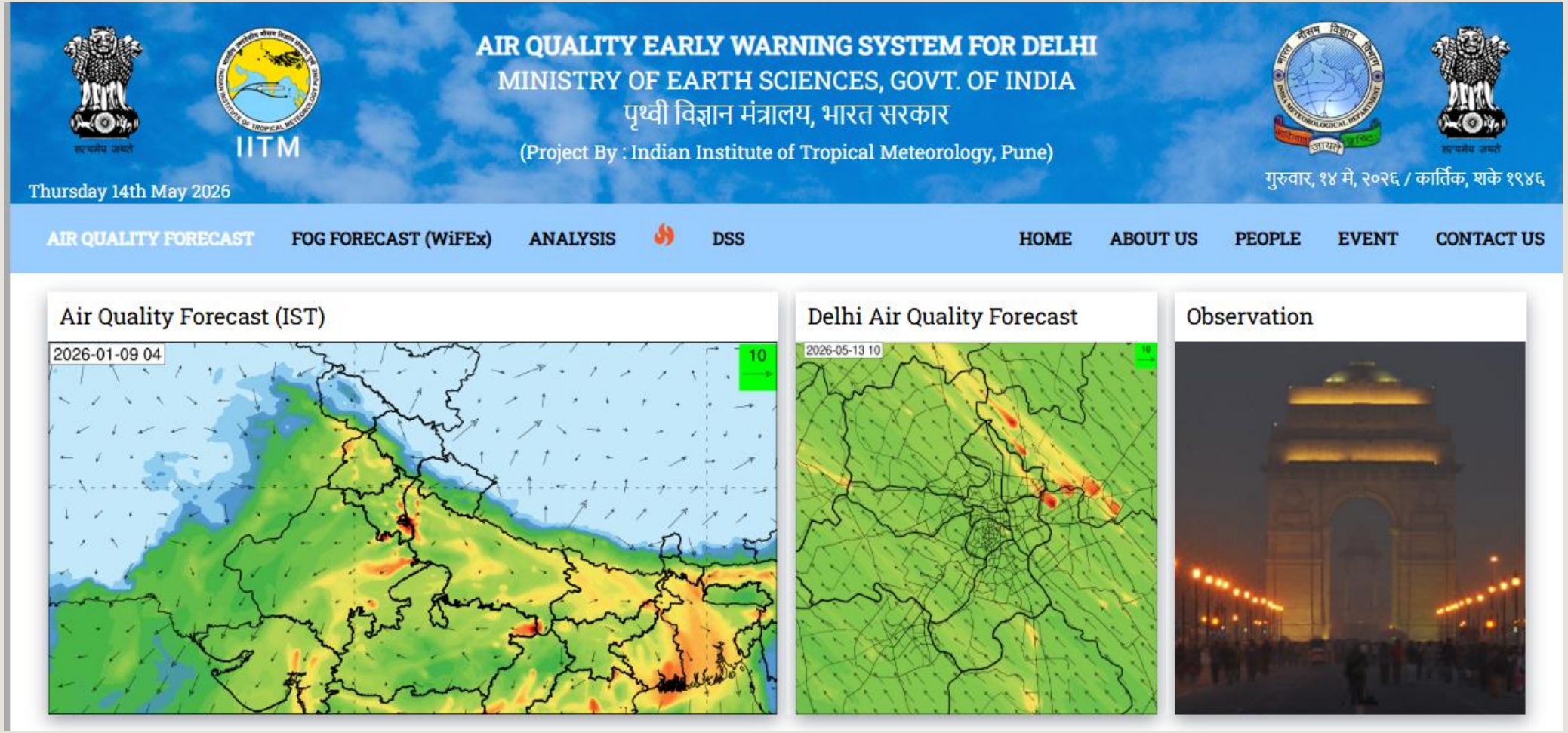
Status
Ready

BIOFIM- an IITM-developed Fish Modelling System





AIR QUALITY PRODUCTS



CHEMISTRY AND CLIMATE MODELLING

CCCR Center for Climate Change Research

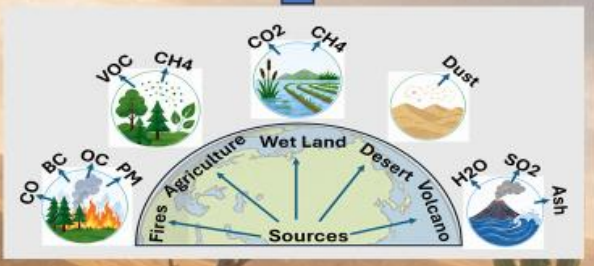
IITM ESSO

Climate information: Planning for day to end of the century

Chemistry-climate models

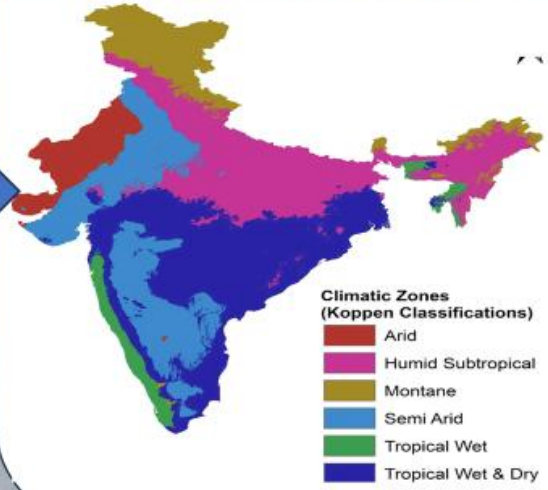
- Present climate (1995-2026)
- Future projections (2025-2100)
- Daily to monthly output
- Regional to state-scale information

- ECHAM6-HAMMOZ at IITM
- AerChemMIP models from CMIP6



- Time interval: Daily to monthly
- Resolution: State level
- Product: Under preparation
- Data: Ready to disseminate

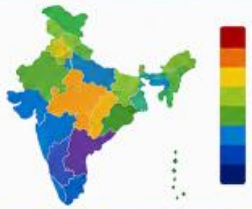
Climate data at all climatic zones of India



Present Climate (1995-2026)

Air pollution: PM, O_3, AQI

Greenhouse gases: CO2, CH_4



State-wise output

Future Climate (2025-2100)

- Climate information: Climate extreme events (floods, droughts, heatwaves, fires)
- Implications : Projections of radiative forcing, temperature and atmospheric heating
- State-wise projection of air pollution

Deliverables & Products

- Projections of air pollutants (O3, NOx, Sulphtes, CO, CO2, HCHO, aerosols)
- Climate Extremes projections under mitigation policies (e.g., reduction of CH4 and CO2)

Key Applications

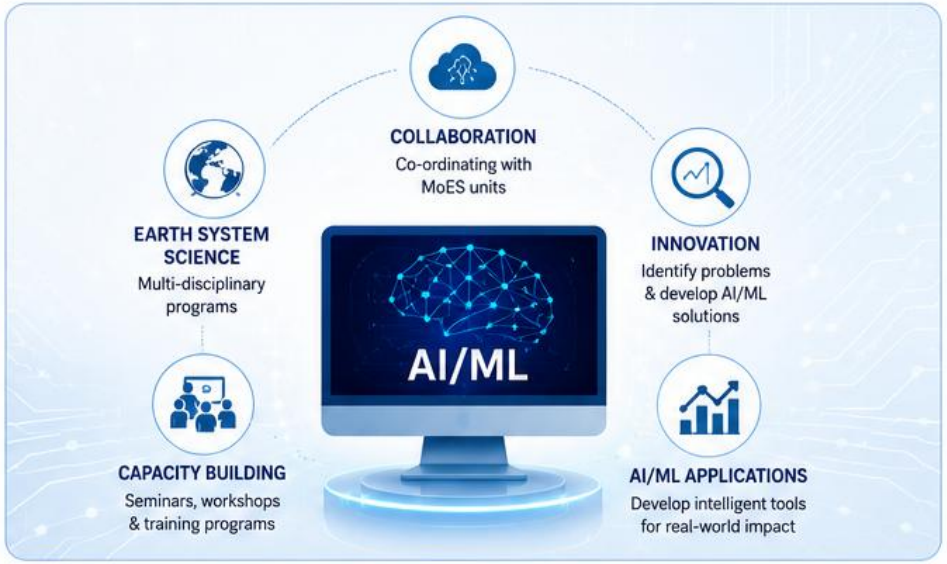
Ministry of Earth Sciences
Government of India

MoES INITIATIVE FOR AI/ML IMPLEMENTATION

VIRTUAL CENTRE ON DEVELOPMENT OF AI/ML/DL AT IITM PUNE

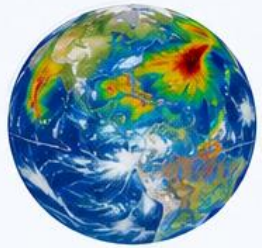
A virtual Centre for Artificial-Intelligence (AI) / Machine Learning (ML) / Deep Learning (DL) has been **established** in IITM Pune.

- To expand the domain through **multi-disciplinary programs** in the field of Earth System Science.
- The center is responsible for **co-ordinating** with the units of **MoES**.
- To **identify problems** that can be addressed with AI/ML based application tools.
- To conduct seminars, workshops, and other **capacity building activities** in the related areas.



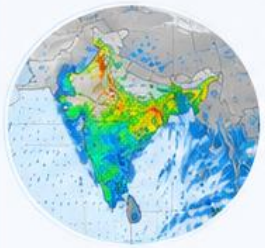
WORK DONE

1 SHORT-RANGE GLOBAL FORECASTING (1 DEGREE)



High-resolution global forecasts for improved weather prediction.

2 DOWNSCALING OF PRECIPITATION DATA



Generating high-resolution precipitation data for better local-scale insights.

3 FIRE LOCATION FORECASTING

Predicting fire-prone areas to support early warning and response.

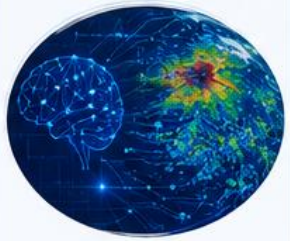
4 FOG FORECASTING

Accurate fog prediction for safer operations and better visibility planning.

5 LIGHTENING / THUNDERSTORM FORECASTS

High-impact thunderstorm and lightning forecasts for disaster risk reduction.

6 DEEP LEARNING FOR IMPROVED GLOBAL PRECIPITATION



Leveraging deep learning to enhance global precipitation prediction in numerical weather systems.

7 DIGITAL TWIN

Building digital twin for realistic simulation and decision support.

Harnessing AI/ML for Advanced Earth System Science Solutions | Better Forecasts. Better Decisions. A Resilient India.

Moderaotr for today's session

Agriculture

Dr. Maheswar Pradhan
maheswar[at]tropmet[dot]res[dot]in

Hydrology

Dr. Ankur Srivastava
ankur[at]tropmet[dot]res[dot]in

Energy

Dr. Medha Deshpande
medha_d[at]tropmet[dot]res[dot]in

Startups

Dr. Sandeep Narayanasetti
sandeep[dot]cat[at]tropmet[dot]res[dot]in

Weather Applications

Dr. Deepeshkumar Jain
deepeshkumar[at]tropmet[dot]res[dot]in

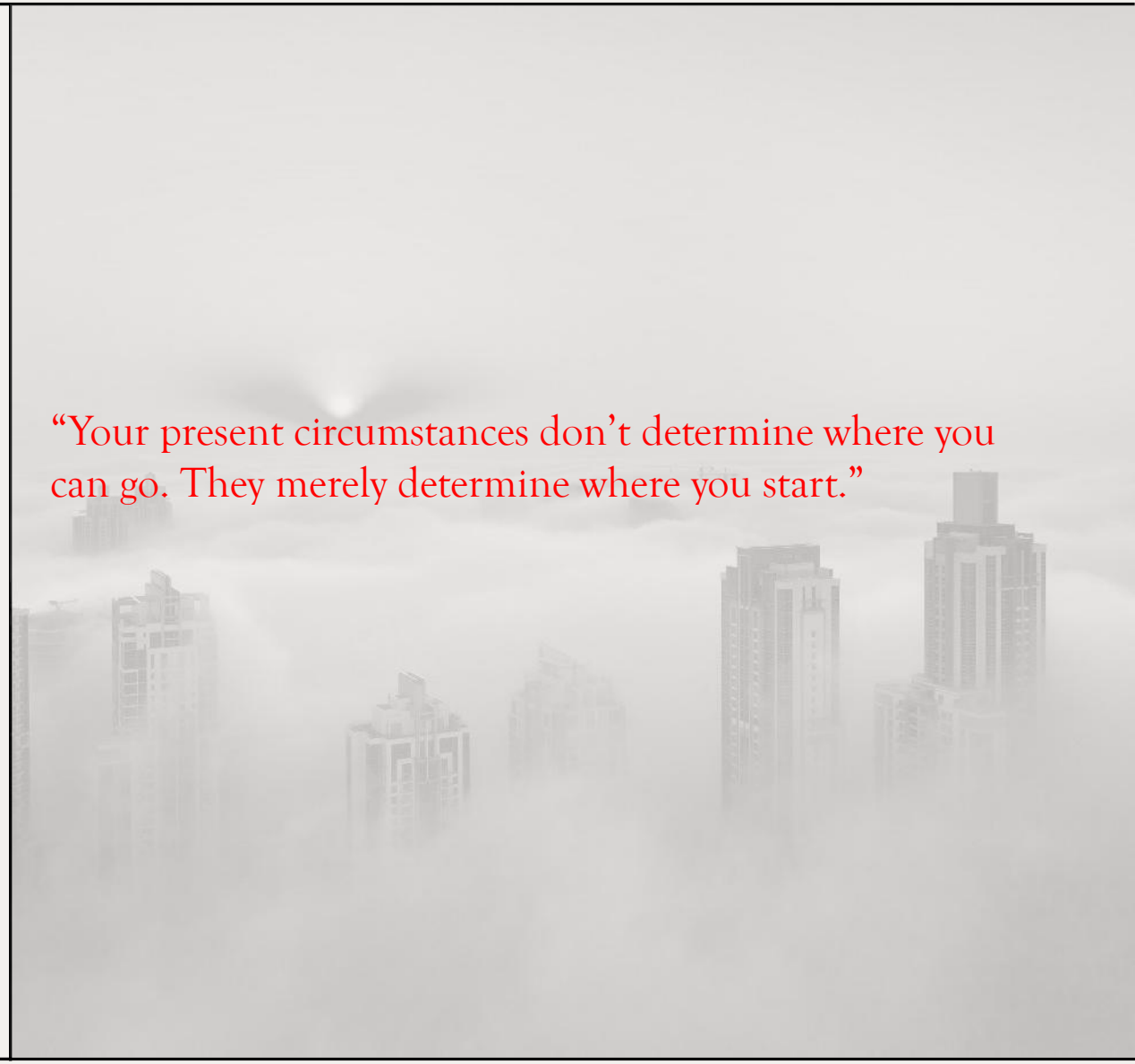
Health

Dr. Rajib Chattopadhyay
rajib[at]tropmet[dot]res[dot]in

Contact for Data Related Queries

Dr. Anupam Hazra
hazra[at]tropmet[dot]res[dot]in

Q&A


“Your present circumstances don’t determine where you can go. They merely determine where you start.”