



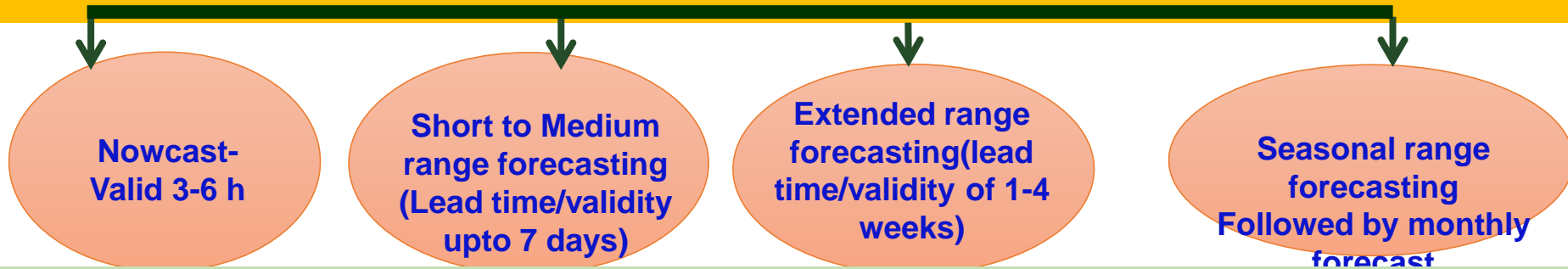
Long-Range Forecast for the Southwest Monsoon Season Rainfall during 2026 and Mission Mausam

02 May 2026

India Meteorological Department



Seamless Forecast System for monsoon



Forecast of

- (I) Forecast of onset, advance and withdrawal of monsoon
- (II) Active and Break Spells
- (III) Rainfall, temperature and other weather parameters
- (IV) Severe weather like heavy rainfall, thunderstorm, lightning, squall/ gusty wind, hailstorm, heat wave, dry spells and wet spells
- (V) Low pressure systems: Low, Depression, Cyclone, Monsoon components like Monsoon trough
- (VI) Large scale processes like El Nino/ La Nina, Indian Ocean Dipole (IOD) and Madden Julian Oscillation (MJO) and their impact on monsoon

Four stage heavy rainfall warning

- **Stage -1:** Heavy rainfall Watch-(3-5 days lead time daily update)
- **Stage-2:** Heavy rainfall Alert: (48 hours prior to the occurrence of event at 12 hourly updates)
- **Stage-3:** Heavy rainfall Warning (24 hours prior to the occurrence of event at 06/12-hourly updates)
- **Stage-4:** 12-Hours prior to occurrence event—at 3-hourly updates.

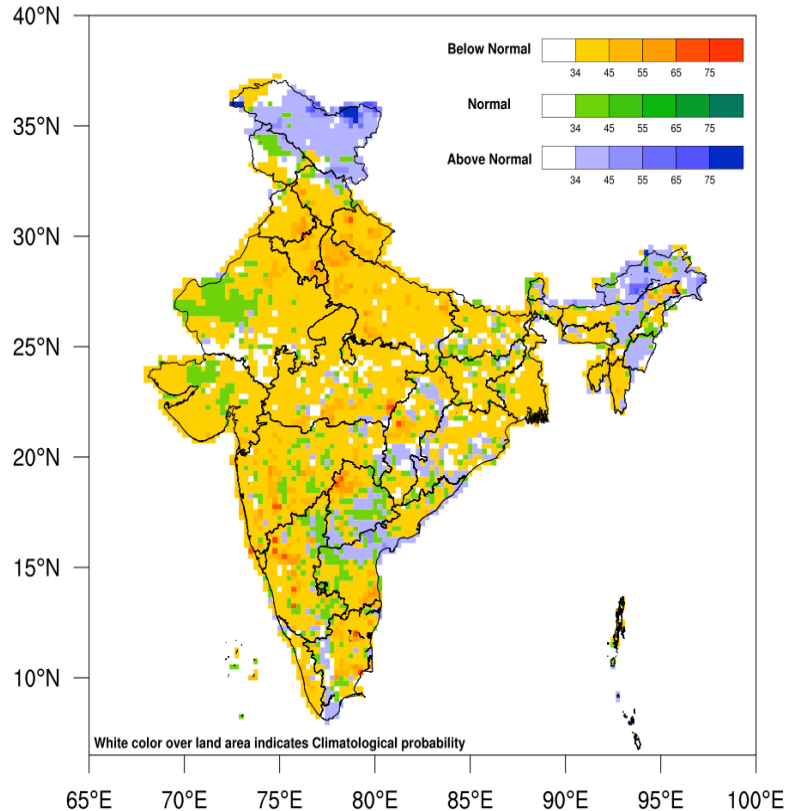
Five category probability forecasts of SW Monsoon Rainfall, 2026

- The five category probability forecasts for the Seasonal (June to September) rainfall over the country as a whole are given below.
- The forecast probabilities for the “Above Normal” and “Excess” rainfall categories are lower than their respective climatological probabilities. Overall, the Southwest Monsoon seasonal rainfall over the country is most likely to be below normal (90–95% of LPA).

Category	Rainfall Range (% of LPA)	Forecast Probability (%)	Climatological Probability (%)
Deficient	< 90	35	16
Below Normal	90 - 95	31	17
Normal	96 -104	27	33
Above Normal	105-110	6	16
Excess	> 110	1	17

Probability forecast for SW monsoon Rainfall 2026

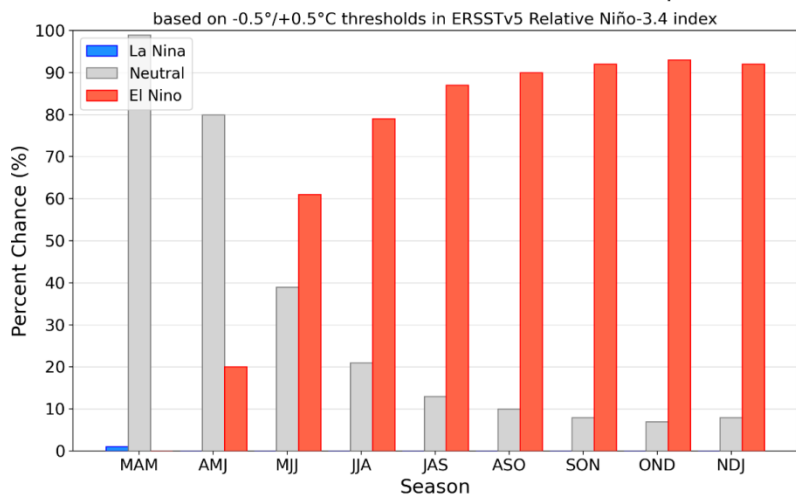
Tercile probability rainfall forecast for 2026 southwest monsoon season



- The southwest monsoon seasonal (June to September) rainfall over the country as a whole during 2026 is very likely to be **below normal**.
- Quantitatively, the seasonal rainfall over the country as a whole is likely to be **92% of LPA with a model error of $\pm 5\%$** .
- The LPA of the monsoon seasonal rainfall over the country as a whole based on 1971-2020 is 87 cm.
 - Below-normal seasonal rainfall is most likely over many parts of the country, except some areas over Northeast, Northwest and South Peninsular India, where normal to above-normal rainfall is likely
 - The white-shaded areas within the land area represent no signal from the model.
 - Below normal rainfall is mainly due to expected El-Nino condition from July
 - Rainfall is likely to be more adversely affected during second half of monsoon season

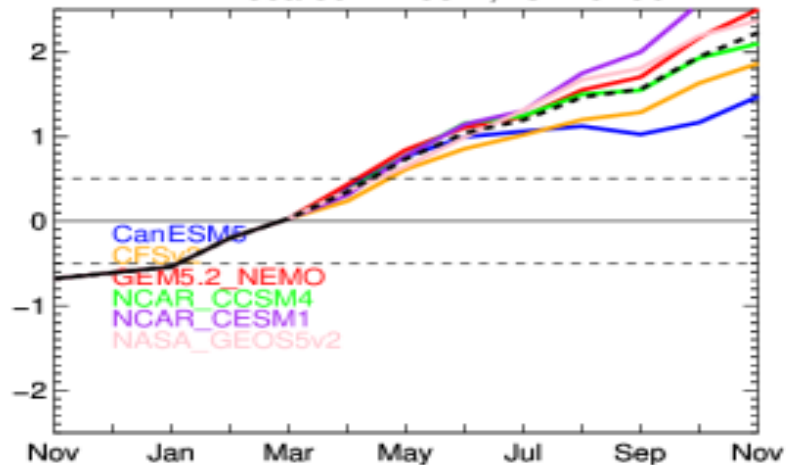
El Nino- Southern Oscillation (ENSO) Forecast based on April 2026 Initial Condition

Official NOAA CPC ENSO Probabilities (issued April 2026)



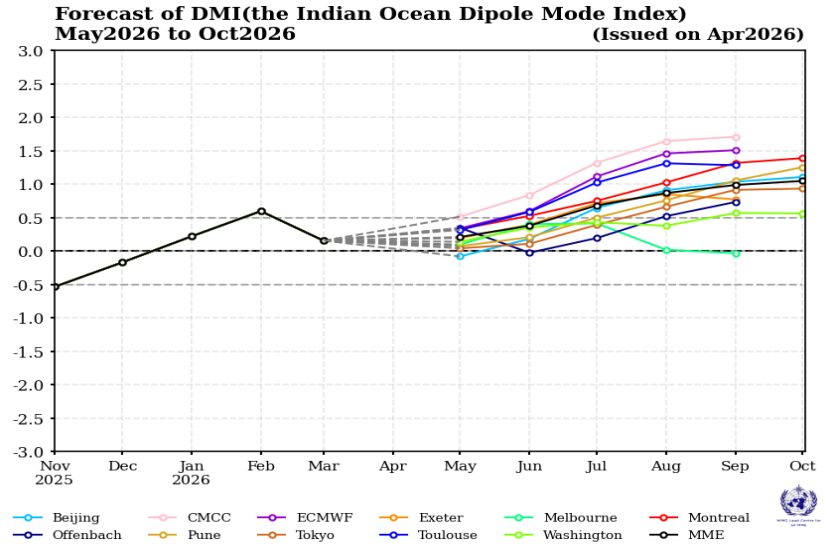
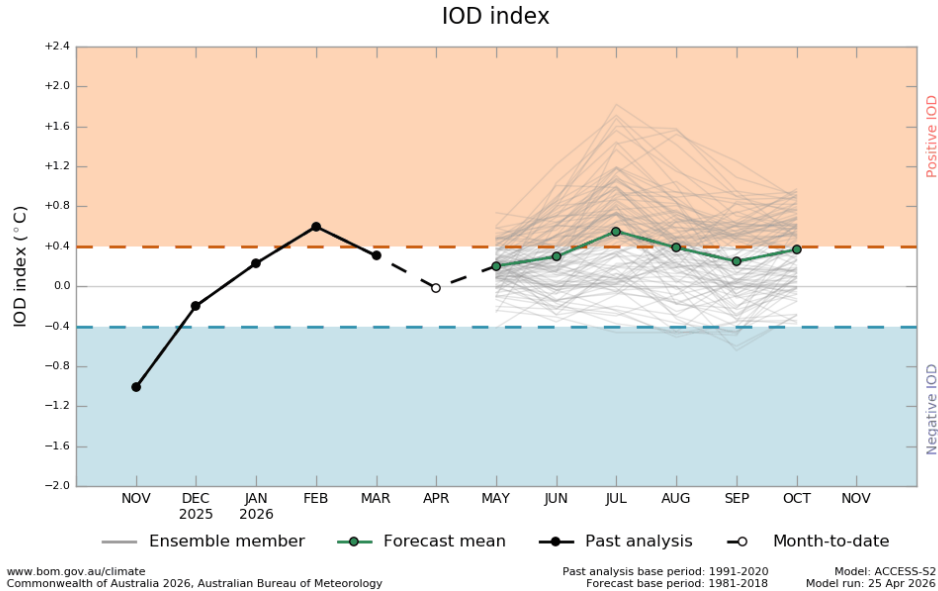
- ❖ Currently, ENSO neutral conditions are prevailing over the equatorial Pacific.
- ❖ Climate Models indicates the development of El Niño conditions during the SW Monsoon season.

NMME scaled Niño3.4, IC=202604



- ❖ Latest weekly Sea Surface Temperature(SST) departures over Niño 3.4 region is -0.1 deg C however, 3 month mean is still around -0.7 deg C.
- ❖ A majority of models indicate El Niño conditions are likely to continue during the monsoon season(Jun to Sep) .

IOD Forecast based on April 2026 Initial Condition

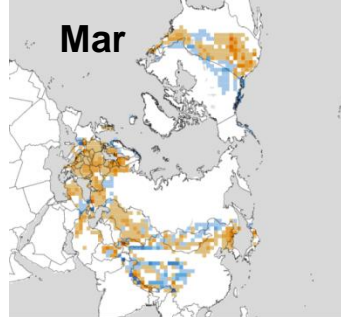
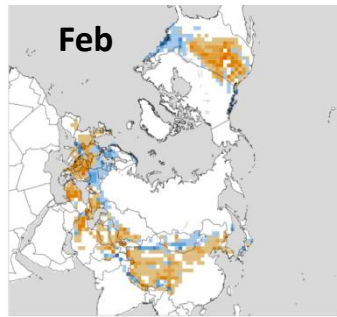
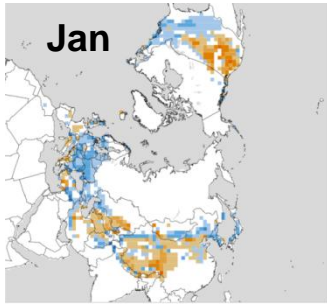


❖ Currently, Neutral IOD conditions are prevailing over the Indian Ocean.

❖ Climate models indicates the development of Positive IOD conditions during the SW Monsoon season.

Monthly Snow Cover Area – 2026

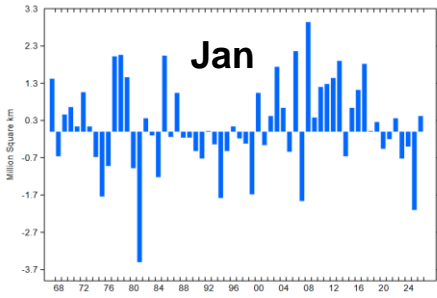
Snow Cover Departure from Normal



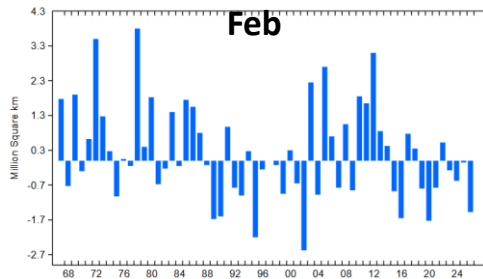
❖ The snow-covered area over NH as well as Eurasia was slightly below normal during January to March 2025.

❖ NH snow cover as well as Eurasian snow cover during winter and spring generally shows a negative relationship with the subsequent Asian summer monsoon.

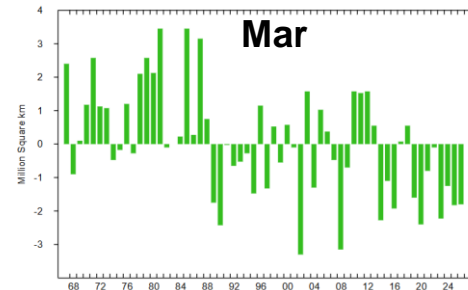
Eurasian Snow Cover Anomalies
1967-2026 January



Eurasian Snow Cover Anomalies
1967-2026 February

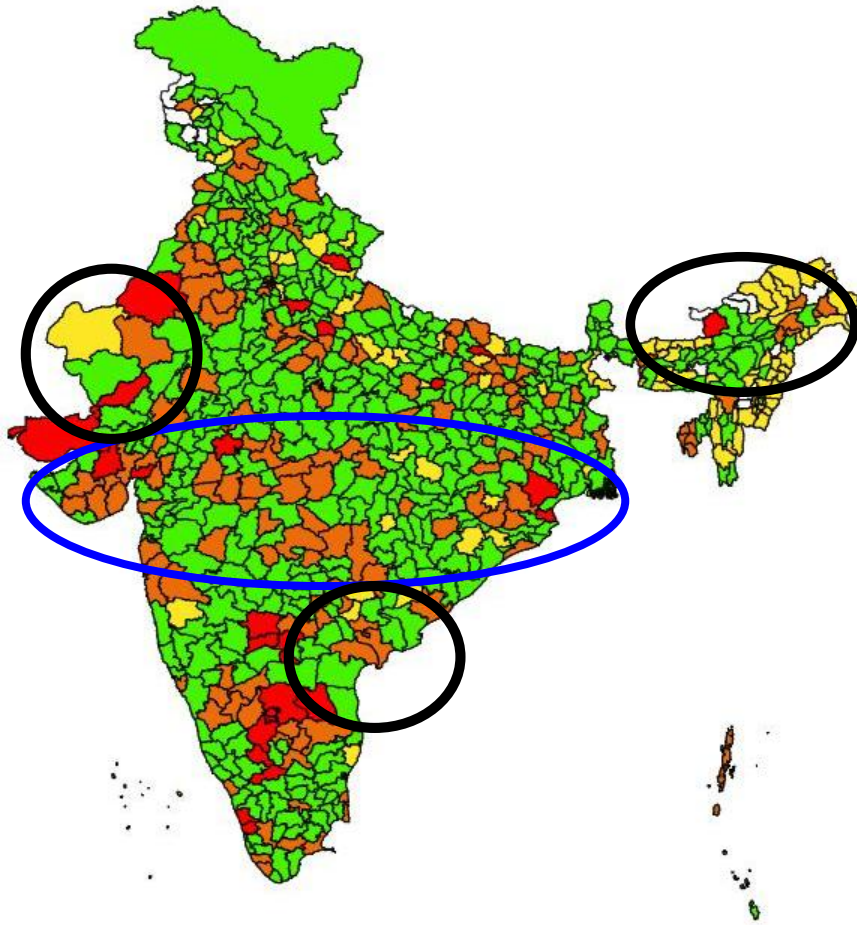


Eurasian Snow Cover Anomalies
1967-2026 March



Data source:
[RUTGERS UNIVERSITY](https://www.rutgers.edu)

Drought normalized vulnerability index based on standardized precipitation index



- Normalized Vulnerability Index
 - Nil (0)
 - Low (> 0 and ≤ 0.25)
 - Moderate (> 0.25 and ≤ 0.50)
 - High (> 0.50 and ≤ 0.75)
 - Very High (> 0.75 and ≤ 1)
- India District

Rainfed Area

- Drought normalized vulnerability index is high over many districts in the rainfed areas in central India
- This area is also expected have below normal rainfall during monsoon season, 2026



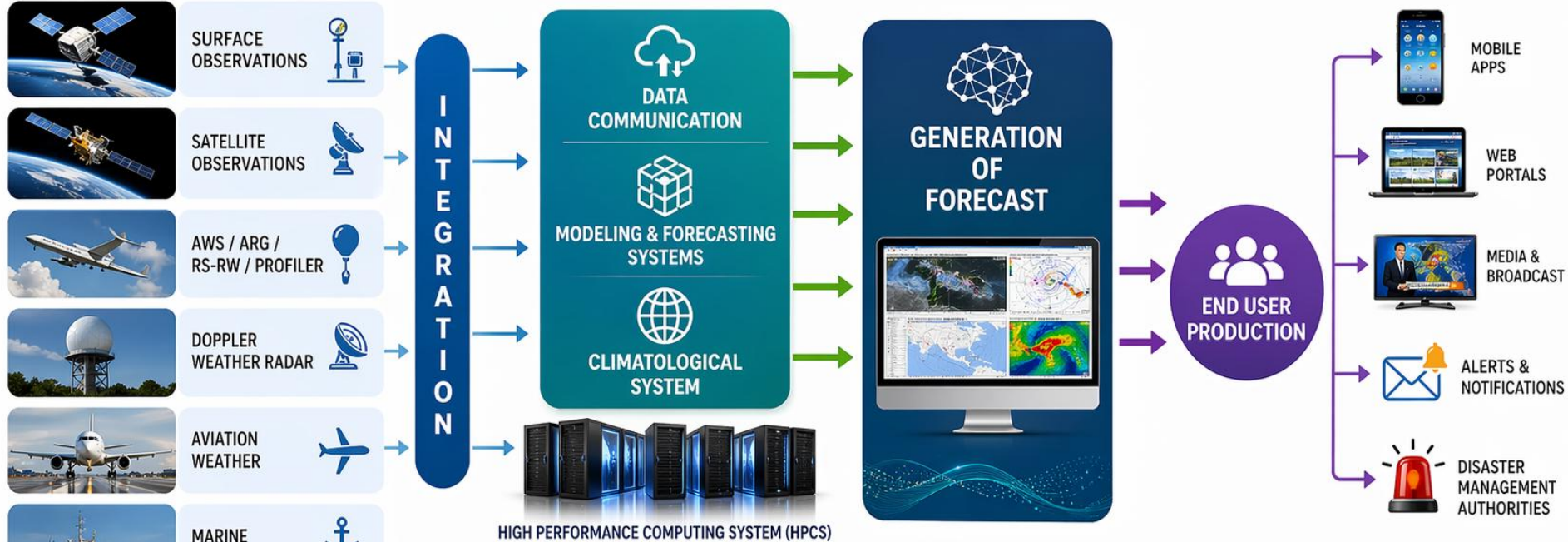
Expected area of Normal to above normal rainfall

WEATHER FORECASTING AND MULTI-HAZARD EARLY WARNING PROCESS

OBSERVATIONAL NETWORK

DATA PROCESSING

DISSEMINATION



NUMERICAL WEATHER PREDICTION (NWP) MODELING WITH HIGH PERFORMANCE COMPUTING SYSTEM (HPCS)



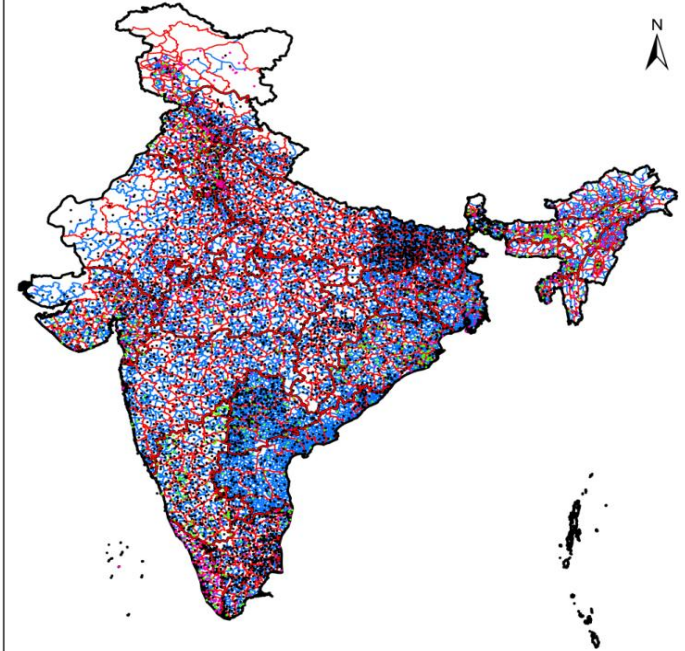
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INDIA METEOROLOGICAL DEPARTMENT



Blockwise Rainfall Monitoring Scheme (BRMS)

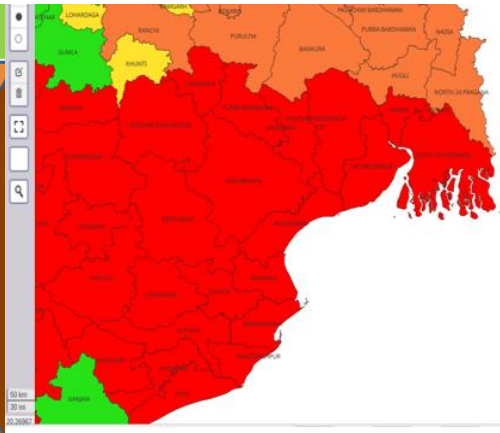
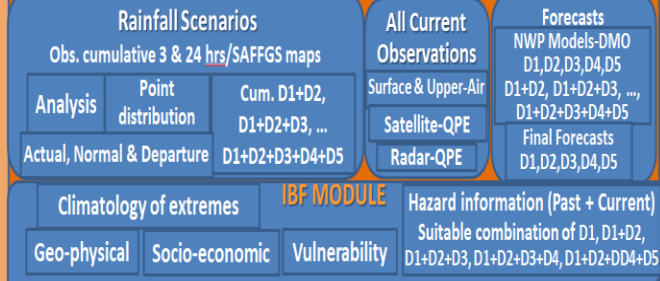
- In 1992, District-Wise Rainfall Monitoring Scheme was launched initially using around 2,000 rain gauge stations.
- In 2025, the network of stations extended to more than 6700 stations
- In 2026 monsoon season it would be 10,300 raingauge stations
- IMD launched the **Block-Wise Rainfall Monitoring Scheme (BRMS)** for 7,200 administrative blocks across India.
- The key applications of BRMS includes
 - **Agricultural Planning,**
 - **Disaster Management,**
 - **Water Resource Management,**
 - **Policy making and inputs for different welfare schemes**

<https://irainshydro.imd.gov.in/block-rainfall>



An example of Impact Based Forecast (IBF) and Risk Based Warning for Monsoonal Heavy rainfall issued twice daily at district level

IBF of Heavy Rainfall Flow



Total Population Affected :155,000
Total No of Airport Affected :0
Railway Station affected: 4
Railway Network affected :East Coast Railway , South Eastern Railway
Hospitals affected: 4
Total No of SEZ affected: 1
Total No of Power Station affected:1
Total No of Power Plants affected:1
Major Towns affected:5

District: Bhadrak WARNING: RED (TAKE ACTION)

IMPACTS

- Flash flood/Water logging in low lying areas;
- Inundation of agriculture field;
- Possibility of some damage to informal/Kutchra road, wall collapsed of vulnerable kutchra houses;
- It may lead to significant rise in water level of rivers;
- Water logging in underpass road and occasional reduction of visibility causing traffic congestion in urban areas during intense spells of rain;
- Municipal services like electricity, water supply etc. will be affected to large extent;
- Supply and transportation will be affected at a few to many places for several days.

ACTION

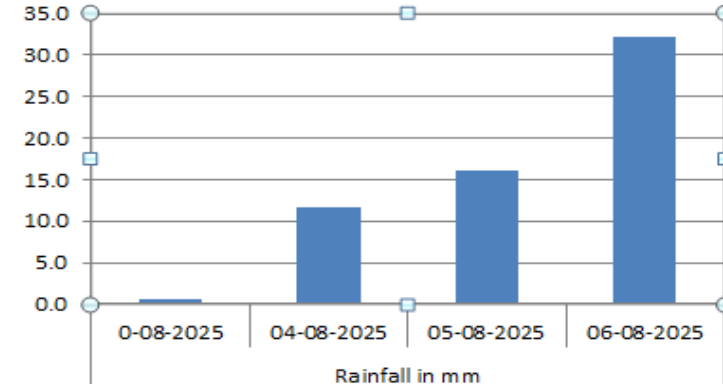
- Keep arrangement for drainage of excess water from inundated agriculture fields;
- Avoid movement in urban areas specially during intense spells of rain; Postpone fertilizer/chemicals application in agriculture field;
- Keep livestock in safe place;
- Avoid movement in affected areas and move to safe place



Flash Flood Guidance

- Location specific Flash Flood guidance advisory up to watershed level (1 lakh watersheds) three times a day
- **Flash Flood Threat:** 6 hours of lead time,
- **Flash Flood Risk:** 24 hours lead time.
- Common Alert Protocol on Flash Flood Guidance will be introduces during monsoon season, 2026

Uttarkashi



24 hours Outlook for the Flash Flood Risk (FFR) till 1730 IST of 05-08-2025 :

Low to Moderate flash flood risk likely over few watersheds & neighbourhoods of following Met Sub-divisions during next 24 hours.

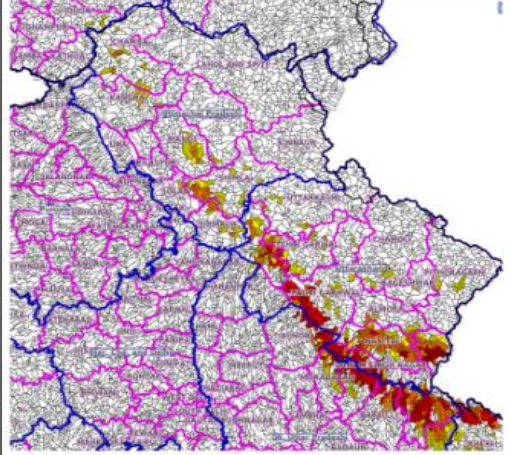
Himachal Pradesh - Chamba, Kangra, Kullu, Mandi, Shimla and Sirmaur districts.

Uttarakhand - Almora, Bageshwar, Chamoli, Champawat, Dehradun, Nanital, Pauri Garhwal, Pithoragarh, Rudraprayag, Tehri Garwal, Udham Singh Nagar and Uttarkashi districts.

West Uttar Pradesh - Bareilly, Bijnor, Moradabad, Pilibhit and Rampur districts.

Surface runoff/ Inundation may occur at some fully saturated soils & low-lying areas over Area of Concern (AoC) as shown in map due to expected rainfall occurrence in next 24 hours.

Product: WRF FFR | Timescale: 24-hr | Region: "INDIA"
Product Date: 2025-08-04 12:00 UTC | Valid Date: 2025-08-05 12:00 UTC



Flash Flood Threat	Flash Flood Risk
High Threat (Take Action)	High Risk (Take Action)
Moderate threat (Be Prepared)	Moderate Risk (Be Prepared)
Low Threat (Be Updated)	Low Risk (Be Updated)

Uttarkashi flashflood LIVE: Flash floods in Uttarakhand leave four dead; over 60 feared trapped

Many feared washed away after water from Kheer Ganga river swept through Dharali in Uttarkashi district; heavy losses of life and property feared;

Updated - August 06, 2025 10:16 am IST

THE HINDU BUREAU

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Quantitative Precipitation Forecast for Riverine Flood Management

Sub basin wise Quantitative Precipitation Forecast (QPF) and Probabilistic QPF (PQPF) in different ranges for the next seven days issued twice daily

QPF categories (mm)	Colour Code
0	
0.1-10	
11-25	
26-50	
51-100	
>100	

QPF categories (mm)	Colour Code
0	
0.1-10	
11-25	
26-37	
38-50	
51-75	
76-100	
>100	

Spatial Distribution		
DRY	Dry	No station reported rainfall
ISOL	One or two places	25% or less number of stations recorded rainfall 2.5 mm
SCT	At a few places	26%-50% number of stations recorded rainfall 2.5 mm
FWS	At many places	51%-75% number of stations recorded rainfall 2.5 mm
WS	At most places	76%-100% number of stations recorded rainfall 2.5 mm

Probability of Occurrence (%)	Colour Code
0-5	
5-25	
25-50	
50-75	
75-100	

Intensity					
M. Dry	NIL	0 cm	VL	Very Light Rainfall	Trace
L	Light Rainfall	Upto 1 cm	M	Moderate Rainfall	2-6 cm
H	Heavy Rainfall	7-11 cm	VH	Very Heavy rainfall	12-20 cm
EH	Extremely Heavy Rainfall	21 cm or more			
ExH	Exceptionally Heavy Rainfall	When the amount is a value near about the highest recorded rainfall at or near the station for the month or season. However, this term will be used only when the actual rainfall amount exceeds 12 cm.			

Achievement in recent years since 2014

Significant improvement in all components of Early Warning system since 2014

1. Augmentation of Observational System from 2014 to 2025

➤ Automated Weather Stations from 675 to 1208, Radars 15 to 49, Upper Air Observational Systems from 43 to 56, Districtwise rainfall measuring stations from 3955 to 6727, Runway weather monitoring systems at airports from 20 to 165, Satellite : 3D to 3DS

2. Augmentation in Computing Resources:

➤ 0.1 PF in 2014 ; 8 PF in 2018 ; 28 PF in 2024

3. Upgradation in Numerical Modelling System

➤ Increase in number of Global Models from 2 to 4 and Regional Models 2 to 5

➤ Resolution of Global models from 25 to 12 and 6 km and regional models from 27 to 3 km

➤ No Ensemble forecast in 2014 to 2 Ensemble forecast Systems by 2018

➤ City forecasts increased from 300 to 1397 and forecast anywhere at anytime (Mausamgram)

4. GIS Based Decision Support System (DSS) for forecasters and Public/stakeholders :

➤ Development of In-House DSS with introduction of Geospatial Technology, Subjective to Objective analysis techniques, Large area to granular scale impact based forecast and risk based warning

5. **Warning and Dissemination** : Mobile Apps, API, CAP, Social Media, Websites etc

6. **Outcome**: 40-50% improvement in forecast accuracy in recent decade compared to previous decade, Block level rainfall monitoring & forecasting, Panchayat level forecast dissemination (Mausamgram), minimisation of loss of lives

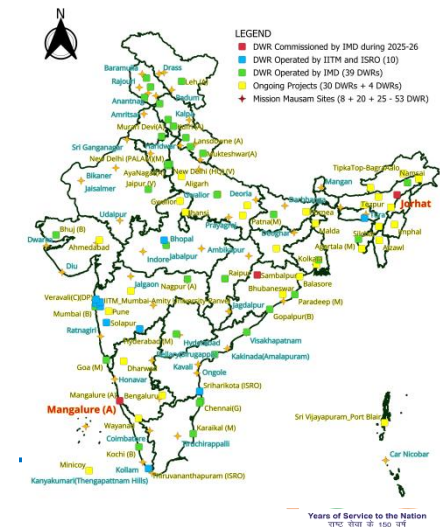
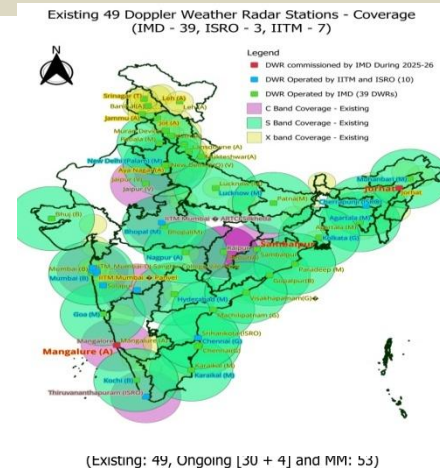
Mission Mausam

Main IMD Deliverables under “Mission Mausam” are as follows

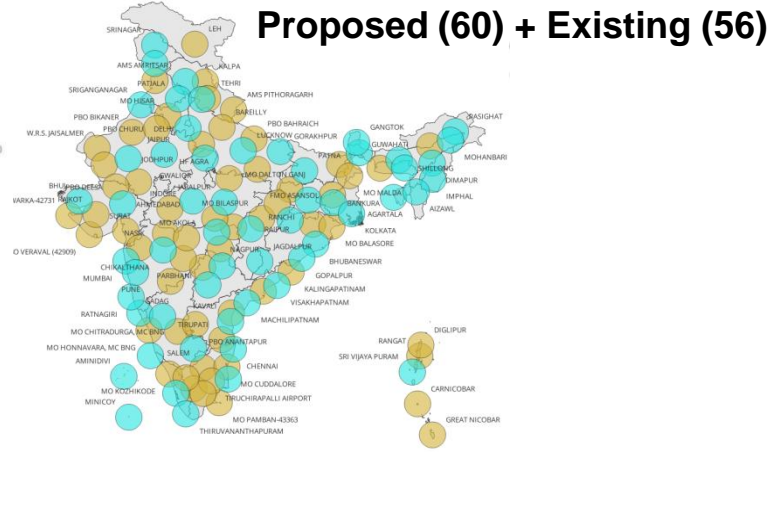
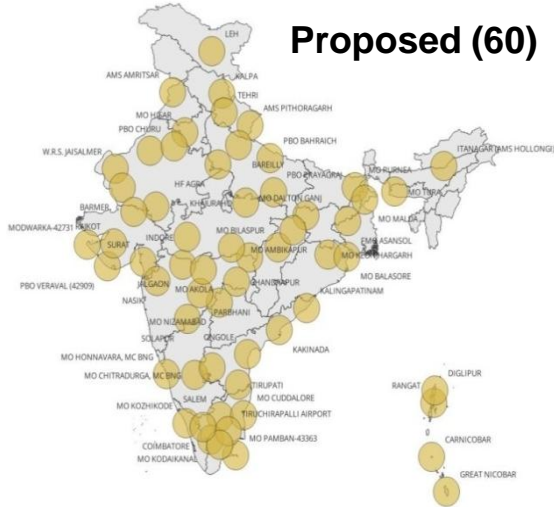
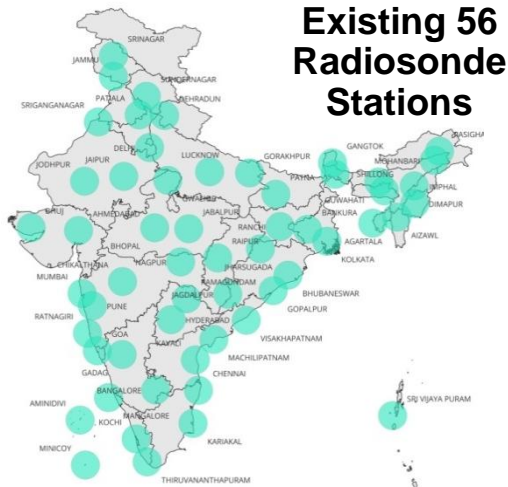
- Commissioning of 53 Doppler Weather Radars: Total radars to go up from 49 to 132
- Establishment of 60 RS/RW stations : Total to go up from 56 to 116
- Commissioning of 100 Disdrometers, 19 Wind profilers, 25 Microwave Radiometers
- Augmentation of Solar Radiation Monitoring Network- 55 Nos.
- Commissioning of 10 Aerosol / Raman LiDARs, Procurement of 20 Skyradiometers
- Expansion of BC Aerosol Network (BC, EC/OC)- 25 stations
- Ozone sonde Network (3 India+ Maitri+ Bharati), Total Columnar Ozone (TCO3)- 5 Nos.
- Commissioning of Visualization and Decision Support System and Operational HPCS)
- Establishment of Radar data centre, R&D Labs for Tropical Cyclones, severe weather events, Aviation Meteorology, Mountain weather and Augmentation of Training centre
- Application of AI/ML

Outcome:

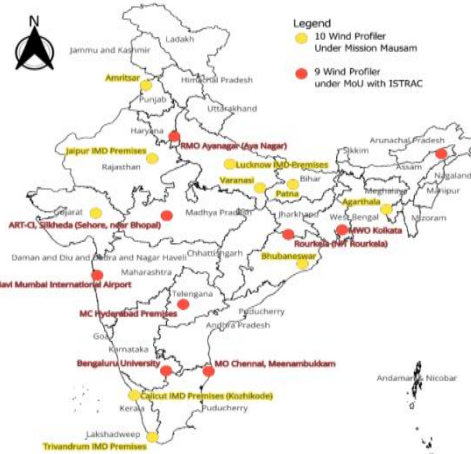
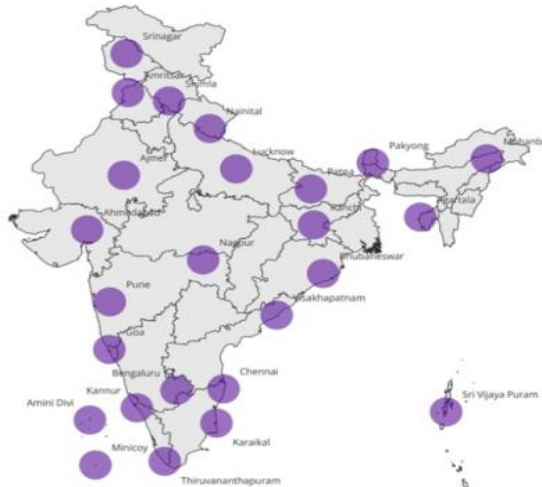
- **Forecasting** of severe weather Hazards at (5x5km) by 2030
- **Dynamic Impact based forecasting** & risk based warning for all severe weather
- **Last mile connectivity** to meet early warning for all by 2030
- 10-15% improvement in forecast accuracy by 2030



Augmentation Plan under Mission Mausam for Upper Air Network



Microwave Radiometers (25)



Wind profilers(19)



Environment Monitoring Network

1. Black Carbon Monitoring Stations (25)

Proposed +15 (2026-27) (10 BC + 5 Total Carbon)

- Phase-I (2015) 16 Stations
- Phase-II (2020) 09 Stations
- **Phase-III (2026-27) 15 Stations**

2. IMD Sky radiometer Network (8)

Proposed + 22 (2026-27)

(12 existing have outlived its life, replacement with lunar skyradiometer)

- Phase-I (2012) 12 Stations
- Phase-II (2018) 08 Stations
- **Phase-III (2026-27) 22 Stations**

3. IMD Precipitation Chemistry Network (11)

Proposed + 9 (2026-27)

(including Fog Chemistry)

4. IMD Ozone Monitoring Network

Existing Total Column Ozone – 2, Proposed – 5

Existing Ozonesonde – 4, Proposed – 5 (including (Maitri, Bharati))

Existing Surface Ozone (IMD Make) – 11, Proposed - 20



5. IMD Aerosol Lidar Network

Two Aerosol Lidar supplied by IRDE, DRDO for Ranichauri (Installed) and Bhopal (to be installed in Jan 2026)

Proposed + 10 (2026-27)

6. Development of High Altitude Observatory Ranichauri

Proposed

- CCN Counter,
- Optical Disdrometer,
- Micro rain Radar
- Aerosol Spectrometer
- Cloud, Aerosol, and Precipitation Spectrometer

Installed

- Skyradioradiometer
- Black Carbon
- GHGs Monitoring
- Trace Gases +PM2.5, PM10
- Solar Radiation (All components)
- Flux Tower

7. IMD Solar Radiation Network

Existing 45 Stations + Maitri, Bharati

Proposed Augmentation +15 stations

New Baseline Surface Radiation Network (BSRN) Stations - +5 Stations



Use of AI/ML in weather forecasting – New initiatives in IMD

AI/ML Initiatives in IMD

Future Plans

❖ AI/ML initiatives for Medium Range Forecasting:

- Pangu, Graphcast and FourcastNet weather Forecasting models are in experimental
- AIML model based on Transformer.
- Accessing of open source models.
- Another AIML model based on cascading of transformers.

❖ AI/ML initiatives for Nowcasting :

- Lightning/Hailstorm Prediction using Radar & Satellite Datasets

❖ AI/ML initiatives for Urban Meteorological Services:

- Downscaling of the Rainfall analysis for city-scale weather
- Fog Probability and Confidence Estimation (FPCE) model

❖ AI/ML initiatives in Data Dissemination

- AI-based language translators are being utilized for disseminating weather related information in Regional/Local languages
- MausamGPT

- Developing few more AI based weather forecasting models and applying Consensus AI based models and NWP Models.
- Applying AI/ML techniques for downscaling up to Panchayat/block level forecasting
- Developing AI Model for severe weather like heatwave, coldwave, cyclone tracks, monsoonal rain, thunderstorm, dust storm
- Quality Control check of AWS data.
- Applicability of AI/ML in Data Assimilation Procedure.
- Applicability of AI/ML techniques of Radar Data such as clutter correction, rectification of beam blockage, de-alias of winds.
- AI/ML based Nowcasting tools
- Applicability of AI/ML techniques of satellite imagery for estimation of various parameter like Cyclone intensity, cumulative heat factor etc..
- Developing consensus forecast from Physics based and AI Based weather forecasting models.



Thank you

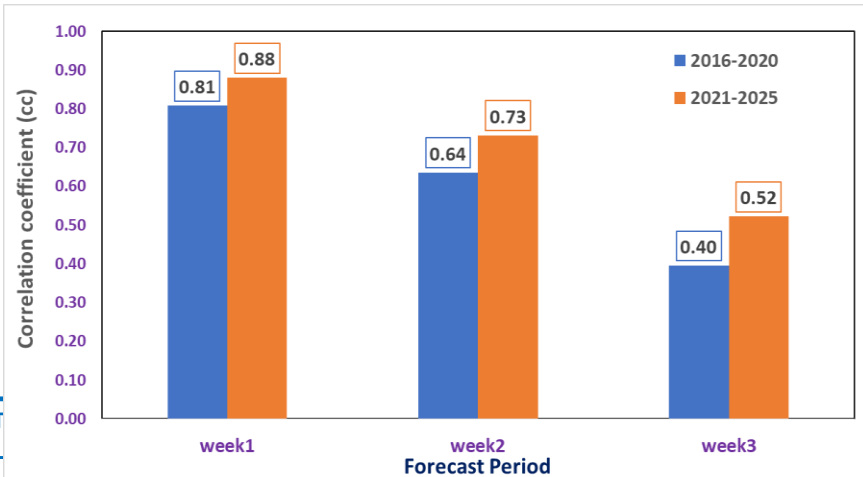
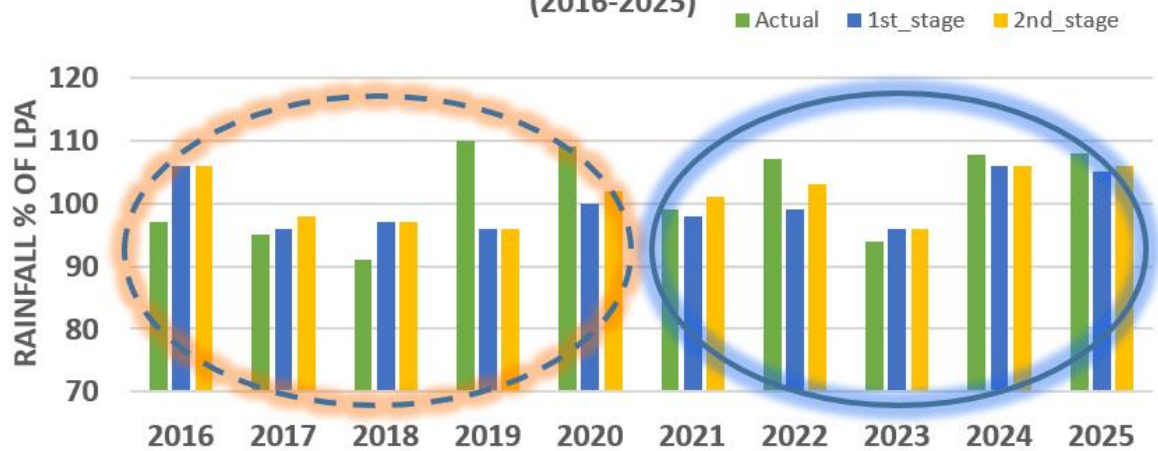


Verification IMD SW Seasonal Rainfall forecast

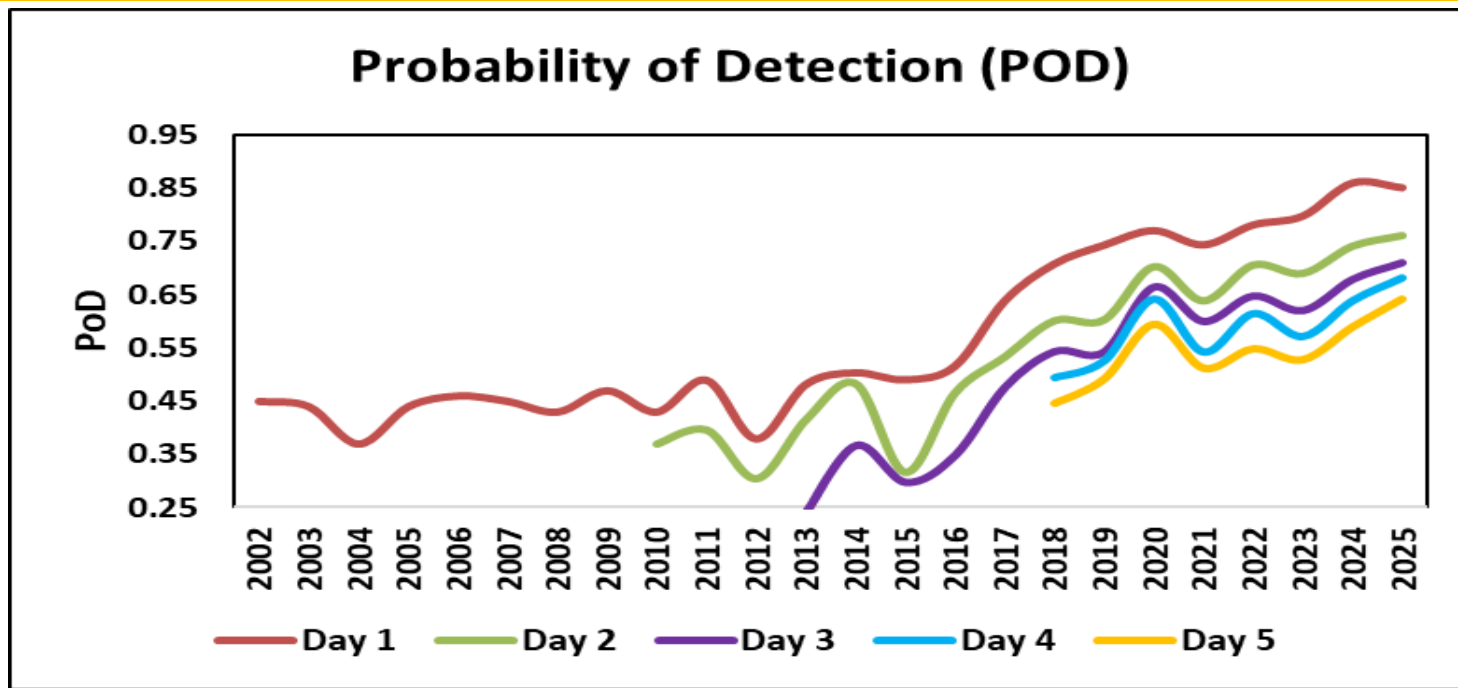
- IMD's seasonal forecast accuracy has improved significantly since 2021 due to new strategy using Multi-Model Ensemble (MME).
- During 2021–2025, the average absolute error for first-stage forecast stands at 3.1% of the Long Period Average (LPA), while the same for second-stage forecast has reduced to 2.2% of LPA.
- Absolute error was 7.2% of the LPA during 2016-2020.
- About 10 – 15 % increase in week 1 & Week 2 Forecast
- About 30 % increase in week 3 Forecast



PERFORMANCE OF IMD OPERATIONAL FORECAST
(2016-2025)



Meteorological Sub-division-wise Monsoon Heavy Rainfall Skill Score 2025

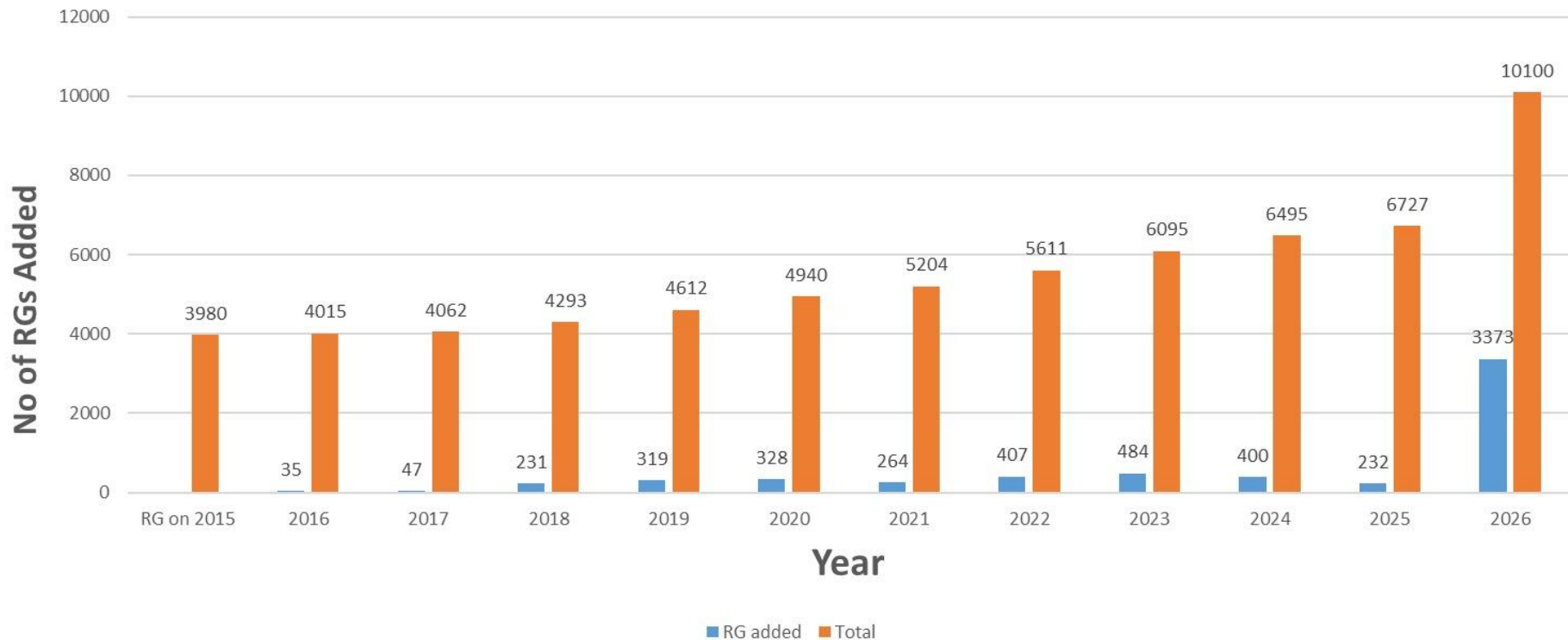


There has been continuous improvement in the Heavy rainfall forecast issued by IMD during monsoon season



Enhanced number of raingauges for Monitoring

RGs Status from year 2015 to 2026



➤ No of rainfall observational stations has increased from 3980 in 2015 to 10100 in 2026

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Verification IMD SW Seasonal Rainfall forecast

IMD forecast correctly indicated the Below Normal Rainfall for the Years 2009, 2014 & 2015

Year	Actual Rainfall in % LPA	IMD Forecast
2007	110	93
2008	102	100
2009	81	93
2010	103	102
2011	104	95
2012	95	96
2013	108	98
2014	89	93
2015	87	88
2016	98	106
2017	96	98
2018	91	97
2019	110	96
2020	109	102
2021	99	101
2022	106	103
2023	95	96
2024	108	106
2025	108	106



El Nino Vs Monsoon

AIRF: ELNINO YEARS						El Nino strength WE – SST anom. 0.5 to 1 ME – SST anom. 1.0 to 1.5 SE SST anom. > 1.5
Southwest monsoon Rainfall during El Niño years						
YEAR	JUN	JUL	AUG	SEP	JJAS	
1951	-3.1	-11	-13.2	-26.6	-13.2	WE
1953	-1.8	14.5	17.6	6.2	10.7	WE
1957	-6.6	9	7.1	-21.6	-0.5	ME
1963	1	-8.4	24.6	-1.5	4.4	WE
1965	-30.1	-4	-24.6	-22.5	-18.6	ME
1968	-10.5	10	-16	-23.3	-8	WE
1972	-26.2	-27.2	-13.8	-23.2	-22.3	ME
1976	-4.8	4	15.1	-14.9	1.9	WE
1982	-17.4	-17.8	8.3	-24.9	-11.4	Me
1987	-21.1	-21.5	-4.6	-10.3	-14.3	ME
1991	11.1	-1.2	2	-19.1	-1.4	WE
1994	22.9	25.1	12.2	-11.3	13.9	WE
1997	3.8	1.5	3.2	-10.2	0.2	SE
2002	2.3	-50.6	-4.4	-19	-20.9	WE
2004	0.6	-13.4	-0.8	-26.6	-9.6	WE
2015	14	-14.4	-21.6	-22.6	-12.7	ME
2023	-7.5	12.8	-36.1	13.1	-5.3	WE

In general, Indian SW monsoon is weaker than normal during the El Nino years. During the period 1951-2022, there were 17 El Nino years and during 7 of these years ISMR was below normal indicating that there is no one to one association between EL Nino and ISMR. However there is stronger inverse relationship between El Nino and rainfall during later half of the monsoon season (particularly with September rainfall)

