

Medium and Extended Range Weather Forecasts for Applications in Disaster Management

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IWM-8 (17-21 March 2025), IITM Pune

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Mean Monsoon Rainfall (JJAS)

Mean % of Heavy rainfall days & Mean % of Very heavy rainfall days





Frequency of Heavy, Very Heavy and Extremely Heavy rainfall over India during the period from 2013 to 2023



Flood Damage Statistics: India





Daily All India and Central India Rainfall Time Series (JJAS 2024)



Heavy Rainfall Events occurred in June to September 2024

Location of Very Heavy Rainfall Events (115.6 – 204.4 mm)

Location of Extremely Heavy Rainfall Events (> 204.4 mm)

Last 5 years comparison





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⁸ Significant Weather Events (JJAS 2024)



Loss of Life due to floods/Heavy Rain

			DIDU
State	Loss of Life		
Andhra Pradesh	<mark>20</mark>		
Arunachal Pradesh	<mark>1</mark>	X	
Assam	<mark>102</mark>		\mathbf{K}
Bihar	<mark>10</mark>		
Chhattisgarh	5		
Delhi	<mark>13</mark>		\mathbf{X}
Goa	<mark>5</mark>	LY.	Y I II
<mark>Gujarat</mark>	<mark>28</mark>		\mathcal{A}
Haryana	<mark>5</mark>	X	X/I
Himachal Pradesh	<mark>34</mark>		\mathcal{N}
Jammu & Kashmir	<mark>3</mark>		
Karnataka	8		
<mark>Kerala</mark>	<mark>397</mark>		
Madhya Pradesh	<mark>100</mark>	1	Disa
Maharashtra	<mark>33</mark>		
Manipur	<mark>2</mark>		comp
Meghalaya	<mark>1</mark>	wмo	-
<mark>Mizoram</mark>	<mark>3</mark>	ОММ	
Nagaland	<mark>5</mark>		
Punjab	<mark>9</mark>	Μι	ılti ⊢
Rajasthan	<mark>25</mark>	6.	NOKO
<mark>Sikkim</mark>	<mark>12</mark>	Je	vere
Telangana	<mark>16</mark>	int	eara
Tripura	<mark>22</mark>		
Uttar Pradesh	14	Di	sast
Uttarakhand		RTN	

Disaster risks are increasing, due to:

 Increasing intensity and frequency of hydrometeorological hazards;

 Increasing value of exposed elements due to development and demographic expansion.

Disaster risk management is a critical component of climate change adaptation.

Multi Hazard Early Warning ofSevereWeatherintegralcomponentofDisaster Management.



NWP Operational Models at IMD Delhi (Nowcasting to ERF) **Impact-based Forecasting Numerical NWP/Climate Models** Temporal Weather Research Forecast Nowcasting < (WRF) regional ۲ to short models; 3 km, 4 times, 3 days HRRR (with radar data assimilation) range Weather Weather Response Impact forecasting / 2 km, every 2 hrs, 12 hrs Information Translation Estimation Scenarios **E-WRF (with lightning data assimilation)** 2 km, 2 times, 24 hrs Medium Global Forecast System (GFS) Model • range **Global Ensemble Forecast System (GEFS)** Weather analysis Extraction of relevant Placing into forecast & forecast data information situational context Mitigation strategies • (Both at 12 km resolution) Multi-Model MME forecast based on 6 Global models. (IMD-٠ Weather-impacted user Ensemble GFS, IMD-GEFS, NCEP-GFS, NCUM, JMA and ECMWF) Weather Information provider (MME) MME based track & intensity with 8 models -IMDGFS, ECMWF, NCEP, NCUM-G, NCUM-R, HWRF, UKMO, ECCC **Climate Forecast System (CFS) coupled models** Extended range (ERF) (16 members) with hidcast of 20 Years (2003-**2020).** 38 km, once in a week 9

IMD's Operational Extended Range Forecast (ERF) System



Verification of Extended Range Forecast (Jun to Sep, 2024)





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Extended Range Forecast of Rainfall (Extended range prediction of monsoon for 2 weeks

- **Issued every Thursday valid for next four weeks : Reasonable skill upto 2 weeks**
- Verification of rainfall forecast for the two active monsoon weeks : (a) 01-08 Aug (b) 22-29 Aug 2024





Obs rainfall/anomaly (22-29 Aug)



Week 1 forecast (issued on 31 Jul)



-15

-10

Week 1 forecast (issued on 21 Aug)



-10

Week 2 forecast (issued on 24 Jul)



Week 2 forecast (issued on 14 Aug

(FCST week2 Anomaly: 00Z22Aug-00Z29Aug) (00Z=0530 hrs IST)



Heavy Rainfall Event 29th July 2024 – Wayanad/Kozhikode Landslides

Meteorological Centre Thiruvananthapuram

On Kerala heavy rainfall of 29-30 July 2024 (IMD Data)

- On 30th July 2024, the state of Kerala reported widespread light to moderate rainfall with Heavy to very heavy rainfall at many places and extremely heavy rainfall at isolated places.
- The extremely heavy rainfall was mainly confined to districts over north and central parts of Kerala.

Extended Range Forecast (Week 2 FC based on 18 July & Week 1 FC Based on 25 Jul



<u>ERF-</u> 18th July: (Thursday), IMD predicted above normal rainfall along the west coast region including Kerala during the week of 25th July to 01st August.

25th July: IMD also indicate higher rainfall over Kerala with prediction of heavy rainfall during all the days of the week (25th July to 01st August)

Extended Range Forecast (Continued)

ERF issued on 18.07.2024

Cumulatively above normal Rainfall was forecasted for Kerala and Mahe during both Week1 and Week 2

भारत सरकार भारत मौसम विज्ञान विभाग (पथ्वी विज्ञान मंत्रालय) मौसम केन्द्र विकास भवन पीओ तिरुवनंतपरम - 695 033

GOVERNMENT OF INDIA INDIA METEOROLOGICAL DEPARTMENT (Ministry of Earth Sciences) METEOROLOGICAL CENTRE VikasBhavan P.O.

Thursday, 18th July 2024

EXTENDED RANGE FORECAST FOR KERALA & MAHE AND LAKSHADWEEP

(Current weather status & outlook for the next two weeks (19th TULY 2024 - 01# AUGUST 2024)

Realized rainfall scenario:

Weekly Rainfall Scenario (11th July 2024 to 17th July 2024): (i)

Actual rainfall along with departure from normal rainfall for Kerala & Mahe and Lakshadweep during the recent past week is shown in the table below.

Subdivision	Actual Rainfall (in mm)	Normal Rainfall (in mm)	Departure (%)
Kerala & Mahe	242.2	155.6	56
Lakshadweep (UT)	128.5	72.8	77

Out of the 14 districts in Kerala, 9 districts received large excess rainfall, 4 districts received excess rainfall and 1 district received normal rainfall. Lakshadweep & Mahe received large excess rainfall.

Seasonal Rainfall Scenario (01st June 2024 to 17th July 2024): SW Monsoon (ii)

Cumulative rainfall for Kerala & Mahe and Lakshadweep during this season from 01st June 2024 to 17th July 2024 is shown in the table below.

Subdivision	Actual Rainfall (in mm)	Normal Rainfall (in mm)	Departure (%)	
Kerala & Mahe	870.7	1020.2	-15	
Lakshadweep (UT)	511.8	505.2	1	

Out of the 14 districts in Kerala, 11 districts received normal rainfall and 3 districts received deficient rainfall. Lakshadweep received normal rainfall & Mahe received excess rainfall.

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- Rainfall is likely to occur at most places in Kerala, Mahe and in Lakshadweep during week 1.
- Cumulatively above normal rainfall is likely over Kerala & Mahe and below normal rainfall is likely over Lakshadweep during week 1.

STATE: NEBALA

PAINTALL AND ALLY INCOME.



Rainfall forecast for week 2: (26th July 2024 - 01st August 2024)

Cumulatively above normal rainfall is likely over Kerala and Lakshadweep during week 2.



Extended Range Forecast (Continued)

Cumulatively above normal Rainfall was forecasted for Kerala and Mahe during Week1 and normal rainfall during Week 2



1

150

Forecast skill ERF for some extreme rain events (2024)

	Extreme cases					
		Rainfall (mm)				
		OBS in mm			Departure	Departure
		(%Dep)	FCST	FCST	(% Dep)	(%Dep)
			Week1	Week2	Week1	Week2
June 14-20	Assam-Meghalaya	314 (149)	134	102	(65)	(10)
July 19-25	Saurashtra-Kutch	176 (304)	128	61	(219)	(55)
	Madhya					
July 19-25	Mahrashtra	130 (150)	96	57	(139)	(22)
July26-Aug 1	Kerala	253 (79)	193	188	(71)	(58)
Aug 16-22	NMMT	183 (145)	167	117	(72)	(9)
Aug 23-29	Gujarat	289 (379)	144	56	(305)	(107)
Aug 30-Sep 5	Telangana	218 (432)	88	85	(131)	(48)
	Coastal Andhra					
Aug 30-Sep 5	Pradesh	147 (303)	85	75	(87)	(33)

Intra-seasonal variability of monsoon 2022



Two active spells of monsoon leading to severe floods :-

(a) 08-14 July, 2022 (b) 05-25 August, 2022



Active Phase of monsoon in July ()8-14 July), 2022

Rainfall anomaly (observations and Forecast) for the active phase of the monsoon for the target week from 8 July -14 July and Week 1, week 2, and week 3 Forecasts











Active Phase in August, 2022

Observed Rainfall anomaly







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MME products at district scale for Heavy Rainfall

	Model	Agency	Resolution
1	GFS	IMD	12 km
2	GEFSmean	IMD	12 km
3	GFS	NCEP	25 km
4	UM	NCMRWF	12 km
5	GSM	JMA	25 km
6	NEPSmean	NCMRWF	12km
7	HRES	ECMWF	20/40km

Forecast up to day 5.
Both mean rainfall at each districts.
Updates two times in a day (10.15 am, and 12.30 pm)
Heavy rainfall forecast also available in the website.
Individual model based forecast including heavy rainfall forecast are also available at GIS platform.



Case studies: Ex. Heavy rainfall events over central India (23 Aug 2022)



MME & Operational forecast for district level warning

27 Aug 2024 (MME)

27 Aug 2024 (Operational)



Skill score of operational forecast during southwest monsoon-2024



PoD : Probability of Detection (Successfully predicted yes event)

FAR : False Alarm Ratio Predicted 'Yes' : Occurrence 'No'

CSI : Critical Success Index MR : Missing Rate





Summary (Challenges & Opportunities)

- Significant improvement in MHEWS and DRR in recent years leading to a drastic reduction in loss of lives, especially due to cyclones and Heat Waves.
- Significant improvement in the POD of heavy rainfall event. Skilful prediction of monsoon active-break phase in extended & medium range time scale. But Extremely heavy rainfall prediction remains challenging.
- Scope for weather hazard monitoring and forecasting through :
- •Dual engine concept : AI/ML application in conjunction with Numerical Weather Prediction (NWP) modeling
- •Improvement in forecast accuracy by 10-15% by 2030
- •Dynamic Impact based forecasting & risk based warning for all severe weather





Thank you