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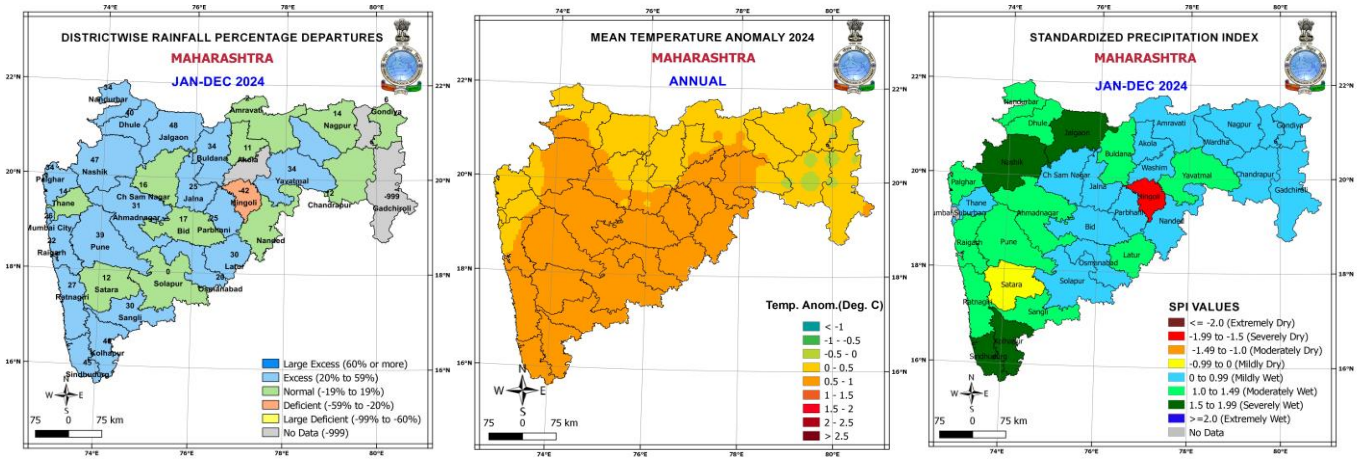
Government of India
पृथ्वी विज्ञान मंत्रालय(एम. ओ. ई. एस.)
Ministry of Earth Sciences (MoES)
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
जलवायु अनुसंधान एवं सेवाएँ
CLIMATE RESEARCH AND SERVICES



महाराष्ट्र राज्य के लिए जलवायु पर वक्तव्य: २०२४

STATEMENT ON CLIMATE FOR THE STATE OF MAHARASHTRA: 2024

द्वारा जारी/ ISSUED BY
जलवायु निगरानी और प्रागुक्ति समूह / Climate Monitoring and Prediction Group
जलवायु अनुसंधान एवं सेवाएँ का कार्यालय/ Office of Climate Research and Services
भारत मौसम विज्ञान विभाग / India Meteorological Department
पुणे 411005 / Pune 411005

महाराष्ट्र राज्य के लिए जलवायु पर वक्तव्य: २०२४
Statement on Climate for the state of Maharashtra: 2024

जलवायु अनुसंधान एवं सेवाएँ का कार्यालय
O/o Climate Research and Services,
India Meteorological Department,
Pune 411 005

Preamble:

It gives me immense pleasure to share this scientific document titled, "Statement on Climate for the state of Maharashtra for 2024" jointly prepared by office of Climate Research and Services, India Meteorological Department, Pune (Ministry of Earth sciences) and the Government of Maharashtra. The statement of climate is attempting to capture the regional climate variability of the state especially with reference to weather parameters like; temperature and rainfall which has huge impact on various sectors like Agriculture, Health, Power, Water Management and many other critical domains. The information on severe weather analysis is also presented in this along with statistics which could be, one of the important inputs for state for its Planning Purpose, Disaster managements issues and over all the economic sustainability and growth. With the continuous projections of climate scientists globally, indicating the possibility of increase in the severe weather events along with its severity, both at global and regional level, this Annual Update will be very useful to all concerned. The data used in this analysis is from 1901 to 2024 (124 years). I am sure this yearly update with climatological perspectives, will create more awareness among all the stake holders, users in the state about the climate of the state and would enable to move parallelly with relevant global and regional scientific directives or advisories in the coming time.

This statement on climate of 2024 also includes the inputs like loss and damage data due to severe weather and other weather-related factors from the Government of Maharashtra. I wish that such joint ventures and integrated approach will yield more benefits to the society, state and in turn to our Nation.

Looking forward for your feedback and will work together.

K. C. Sai Krishnan,
Head, Climate Research and Services,
India Meteorological Department,
Pune.

July 2025

HIGHLIGHTS

The Maharashtra State averaged annual mean land surface air temperature (26.19^{0}C) during 2024 was +0.49^{0}C warmer than its Long Period Average (LPA) for the period 1991-2020 thus making it the warmest year on record for the state since 1901.

The above-normal annual mean temperature in 2024 was primarily driven by significantly higher-than-average seasonal mean temperatures during the winter and post-monsoon seasons. The winter season recorded an anomaly of +1.1°C, making it the second warmest since 1901, while the post-monsoon season exhibited an anomaly of +0.7°C, ranking as the fifth warmest since 1901. Notably, the minimum temperature anomaly (+0.81°C, second warmest since 1901) was substantially higher than the maximum temperature anomaly (+0.16°C, 11th warmest since 1901), indicating a more pronounced warming trend in nighttime temperatures.

Out of 36 districts of the state, 21 received excess rainfall (+20% to +59% of its 1971-2020 period LPA),11 received normal rainfall (-19% to +19% of its LPA) and one district received deficient rainfall (-59% to -20% of its LPA). Data of three districts is not available.

Objective

The objective of this brief report is to provide the analysis of state's temperature, rainfall and extreme weather events that occurred during 2024. This report will be useful for various stakeholders and general public who are interested on the latest weather and climate conditions and its impact in 2024.

Introduction

India Meteorological Department (IMD) is the official agency responsible for providing operational weather and climate services required for the country in various sectors. IMD provides climate services through its office of the Climate Research and Services (CRS) situated in Pune. As a part of its climate monitoring activities, the CRS office, in coordination with IMD's state Meteorological Centers and state governments has decided to issue the statement of annual climate every year since 2021 for each individual state in line with the annual statement of climate issued for the country. This statement provides important information about the monthly, seasonal and annual state averaged temperature, rainfall and Standardized Precipitation Index (SPI) for the year 2024, along with long term trends for some parameters. Additionally, it includes state-specific information related to various extreme weather and climate events experienced during 2024.

Temperature

The monthly, seasonal and annual maximum, minimum and mean temperature anomalies averaged over the state of Maharashtra for the year 2024 is given in the **Fig.1**. The anomalies were computed based on the LPA for the period 1991-2020. Top 10 warmest/coolest months/seasons are marked on the graph. It is worth noting that the winter (January-February) and post-monsoon (October-December)

seasons were unusually warmer for the state compared to the pre-monsoon and monsoon seasons. In 2024, the state experienced a warmer-than-usual climate. The annual maximum temperature was +0.16°C above average (11th warmest since 1901), while the minimum temperature was +0.81°C higher, making it the second warmest on record since 1901. The mean temperature for the year was +0.49°C above the historical average, marking 2024 as the warmest year on record for the state. The highest maximum temperature anomaly of +0.9°C occurred in August, while the highest minimum temperature anomaly of +2.3°C was recorded in December.

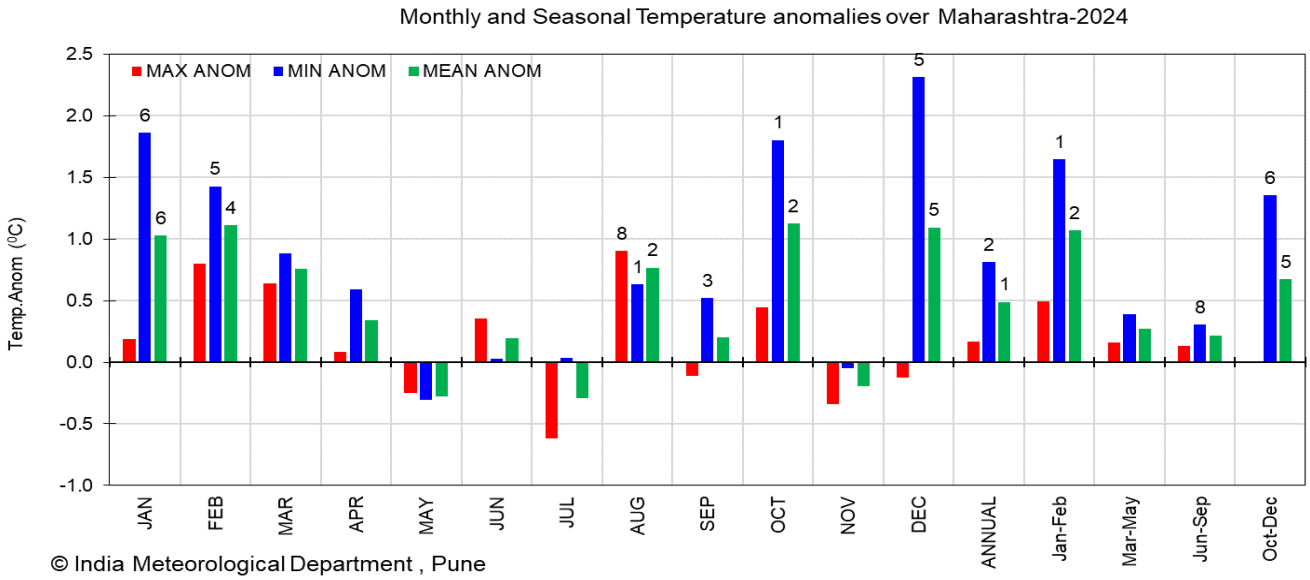
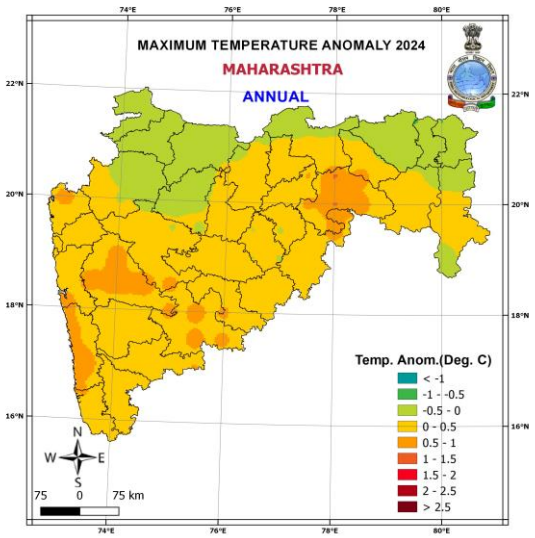
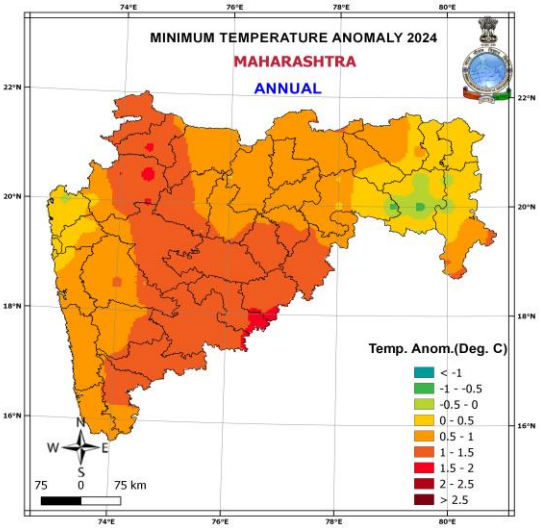


Fig. 1: Monthly and Seasonal Maximum, Minimum and Mean Temperature anomalies averaged over Maharashtra during 2024.The anomalies were computed from the LPA base period of 1991-2020
The numbers above/below the bar indicate top 10 warmest/coolest ranking since 1901

The spatial pattern of annual maximum, minimum and mean temperature anomalies over Maharashtra during 2024 is given in **Fig 2**. The temperature anomalies across most parts of the state were within ±1°C. However, several areas in Madhya Maharashtra and Marathwada experienced minimum temperatures that were +1°C to +2°C higher than normal.





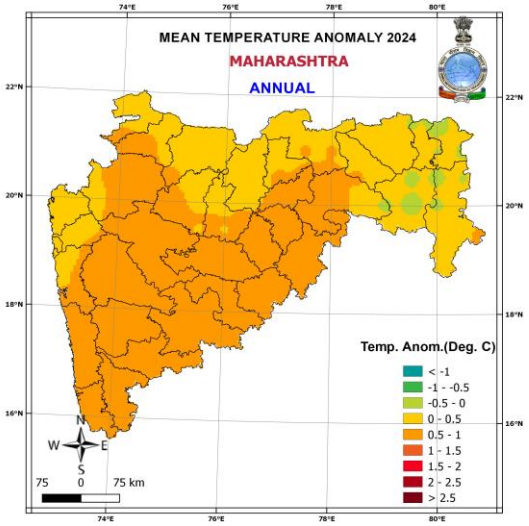


Fig. 2: Spatial pattern of Annual Maximum, Minimum, and Mean Temperature anomalies over Maharashtra during 2024. The anomalies were computed from LPA for the base period of 1991-2020

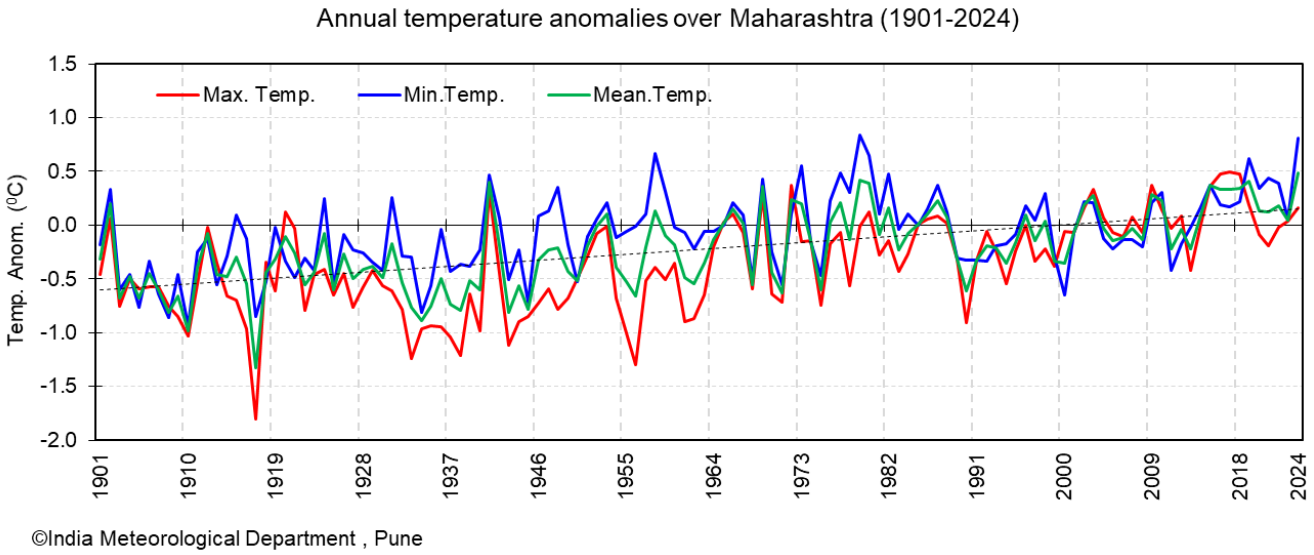


Fig. 3: Annual maximum, minimum and mean land surface air temperature anomalies averaged over the State of Maharashtra for the period 1901-2024.The anomalies were computed with respect to the base period of 1991-2020. [The dotted blackline indicates the linear trend in the annual mean temperature time series]

The time series of variation of annual maximum, minimum and mean land surface air temperature anomalies averaged over the state for the period 1901-2024 is given in **Fig 3**. A significant increasing trend of +0.61^{0}C/100 years is observed in the state-averaged annual mean temperature for the period 1901-2024. This trend is more pronounced in terms of maximum temperature (+0.72^{0}C/100 years) compared to minimum temperature (+0.50^{0}C/100 years).The five warmest years on record for Maharashtra, in order, are 2024(anomaly+0.49°C), 1979(+0.415°C), 2019(+0.404°C), 1941(+0.399°C) and 1980(+0.389°C).

Fig.4(a and b) shows daily variation of minimum and maximum temperature anomalies during the year, respectively. The anomalies were computed with respect to the base period of 1991-2020.The state was relatively warmer in terms of minimum temperature during the winter season as a whole and also during August, October and December months. In terms of maximum temperature, the state was warmer in February, March and August months and relatively cooler in May, July and November months.

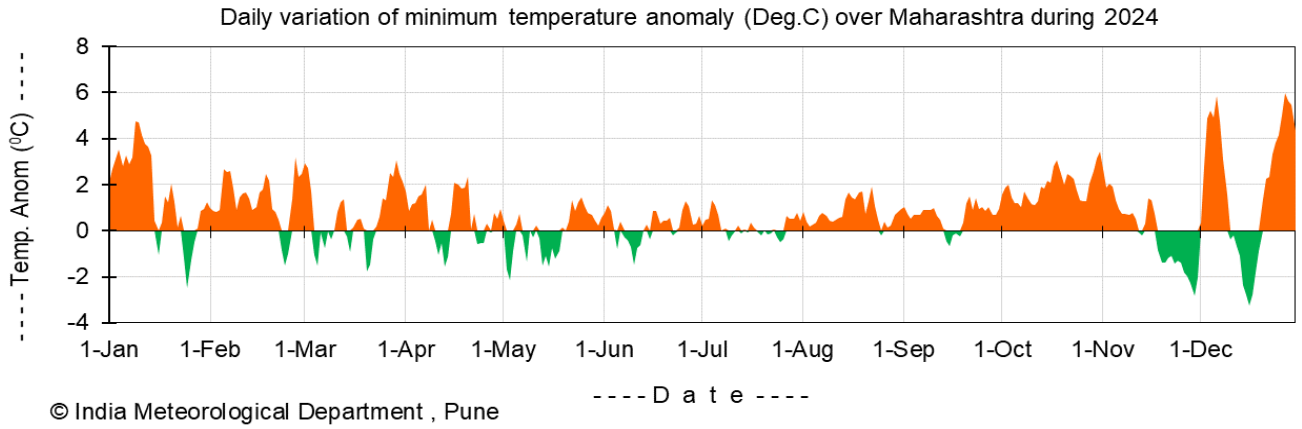


Fig. 4(a): Daily variation of minimum temperature anomaly (^{0}C) over Maharashtra during 2024

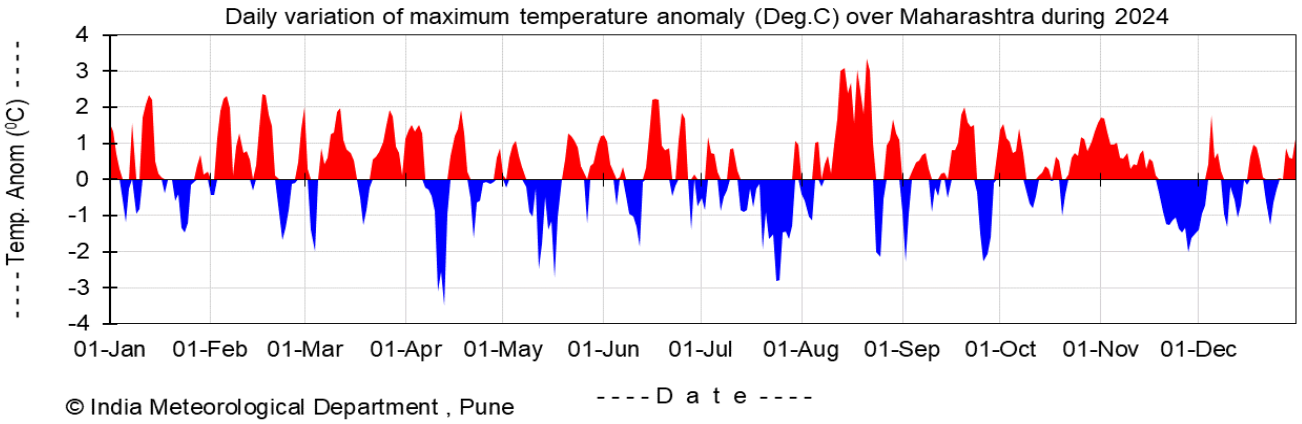


Fig. 4(b): Daily variation of maximum temperature anomaly (^{0}C) over Maharashtra during 2024

Rainfall

Based on 1971-2020 climatology, Maharashtra state as a whole receives 0.7 % of its annual rainfall during the winter season (Jan-Feb), 2.3% during the pre-monsoon season (Mar-May), 88.4 % during the southwest monsoon season (Jun-Sept) and 8.6 % during the post-monsoon season (Oct-Dec). Thus, though the southwest monsoon season is the principal rainy season for the state, state also receives a portion of rainfall during the post-monsoon season.**Fig.5** shows the annual percentage departure of rainfall over different districts of Maharashtra during 2024. The anomalies were computed based on the 50-year LPA for the period 1971-2020. Out of 36 districts of the state, 21 received excess rainfall (+20% to +59% of its 1971-2020 period LPA),11 received normal rainfall (-19%

to +19% of its LPA) and one district (Hingoli) received deficient rainfall (-59% to -20% of its LPA). Data of three districts remain unavailable.

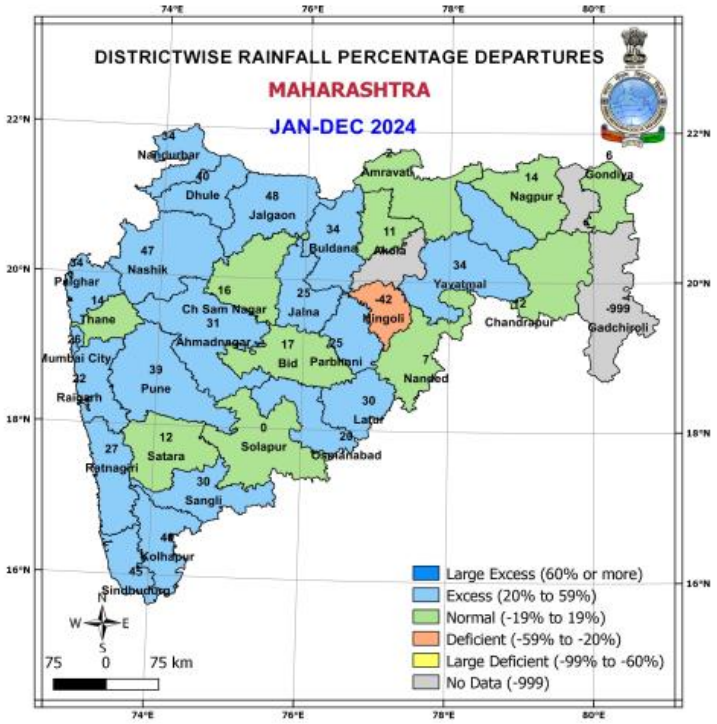


Fig. 5: District-wise annual rainfall percentage departures

The daily variation of rainfall (mm) during the year for the state is shown in **Fig. 6(a)**. The state experienced near-normal rainfall on most days throughout the monsoon season. However, in July, there was a period of above-normal rainfall over several consecutive days, followed by a stretch of below-normal rainfall in August for a similar duration.

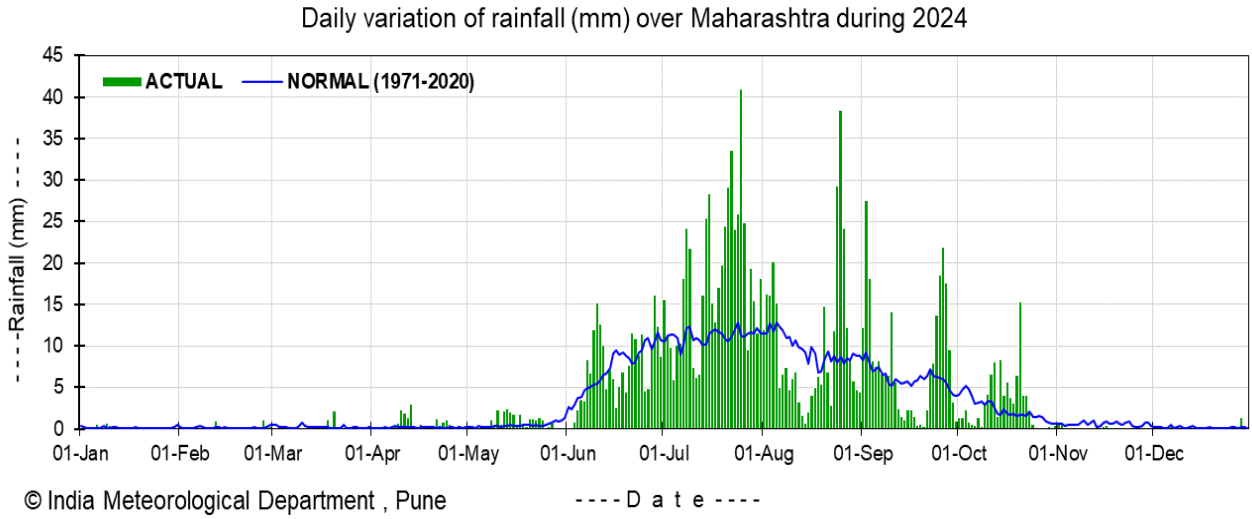


Fig. 6(a): Daily variation of rainfall (mm) averaged over Maharashtra during the year

The time series showing the variation in the percentage departure of seasonal and annual rainfall for the state for the period 1901-2024 are shown in **Fig. 6(b) and6(c)**respectively. The departures are calculated with respect to the LPA base period of 1971-2020. During the monsoon season, and for the year 2024 as a whole, the state received 126 % and 123% of its LPA rainfall respectively.

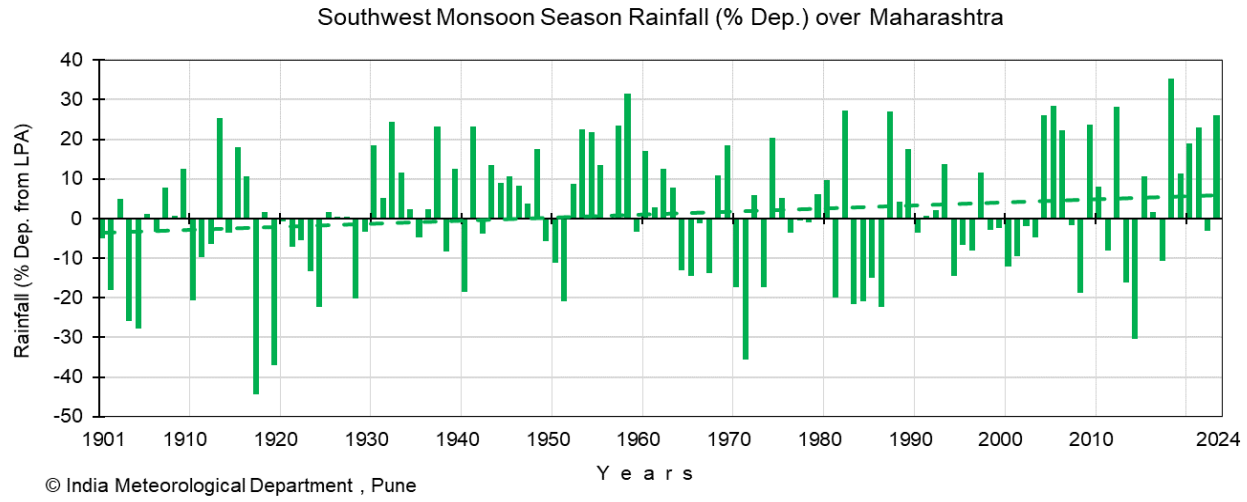


Fig. 6(b): Time series of % departure of southwest monsoon rainfall averaged over Maharashtra (1901-2024)

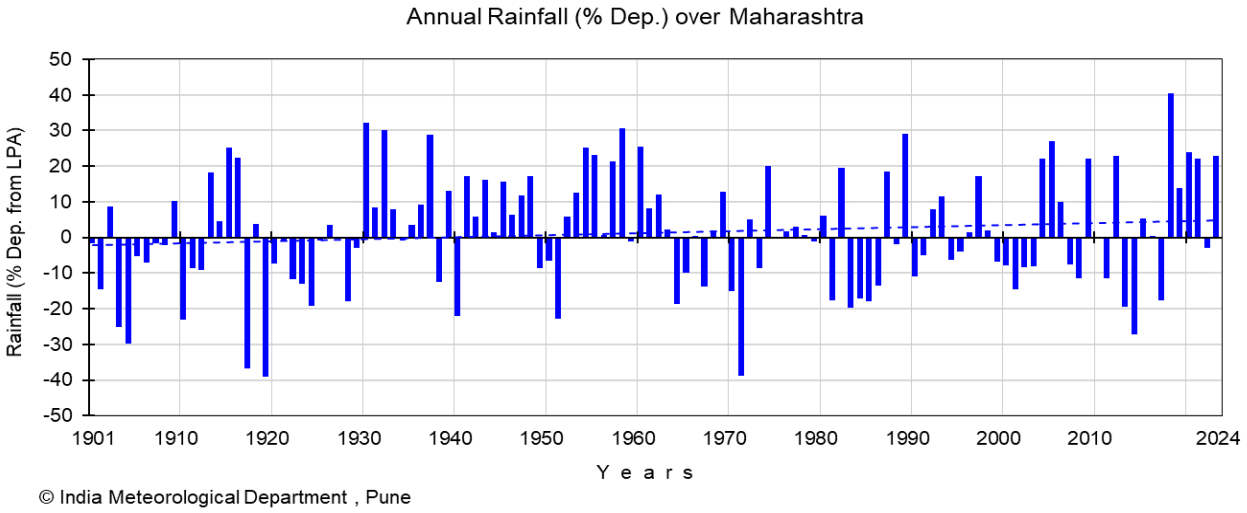


Fig. 6(c): Time series of % departure of annual rainfall averaged over Maharashtra (1901-2024)

Table 1 shows the monthly, seasonal and annual rainfall statistics for the state for the year 2024. The state experienced excess rainfall during the crucial monsoon season, following a period of large excess rainfall in the preceding pre-monsoon season. During the post-monsoon season, which typically sees limited rainfall, the state received normal precipitation. However, in the winter season characterized by minimal rainfall, it experienced a deficiency. Despite these seasonal variations, the overall annual rainfall remained on the excess side.

TABLE 1

MONTH / SEASON	ACTUAL (mm)	NORMAL (mm)	% DEP.	CATEGORY
JANUARY	1.6	4.6	-66.3	LD
FEBRUARY	2.5	3.2	-22.5	D
WINTER SEASON	**4.1**	**7.8**	**-48.0**	**D**
MARCH	4.8	6.2	-22.6	D
APRIL	20.9	5.6	273.7	LE
MAY	21.6	14.4	50.3	E
PRE-MONSOON SEASON	**45.2**	**26.2**	**72.6**	**LE**
JUNE	210.0	209.8	0.1	N
JULY	530.4	324.2	63.6	LE
AUGUST	286.3	280.2	2.2	N
SEPTEMBER	225.5	180.3	25.1	E
MONSOON SEASON	**1252.1**	**994.5**	**25.9**	**E**
OCTOBER	86.2	74.0	16.5	N
NOVEMBER	2.3	17.8	-86.9	LD
DECEMBER	2.3	4.6	-49.1	D
POST-MONSOON SEASON	**90.9**	**96.4**	**-5.7**	**N**
ANNUAL	**1385.3**	**1124.9**	**23.2**	**E**

CATEGORY		
	LARGE EXCESS [LE]	+60 % OR MORE
	EXCESS [E]	+20 % TO +59 %
	NORMAL [N]	-19 % TO +19 %
	DEFICIENT [D]	-59 % TO -20%
	LARGE DEFICIENT [LD]	-99 % TO -60 %
	NO RAIN [NR]	-100%

The district-wise trend in annual rainfall for the period 1951-2022 is given in **Fig 7**. Among all the districts in the state, Nashik and Satara districts exhibited a significant increasing trend. In contrast, a significant decreasing trend was observed in the three neighboring districts of Hingoli, Yavatmal and Chandrapur. The remaining districts did not show any significant increasing or decreasing trend.

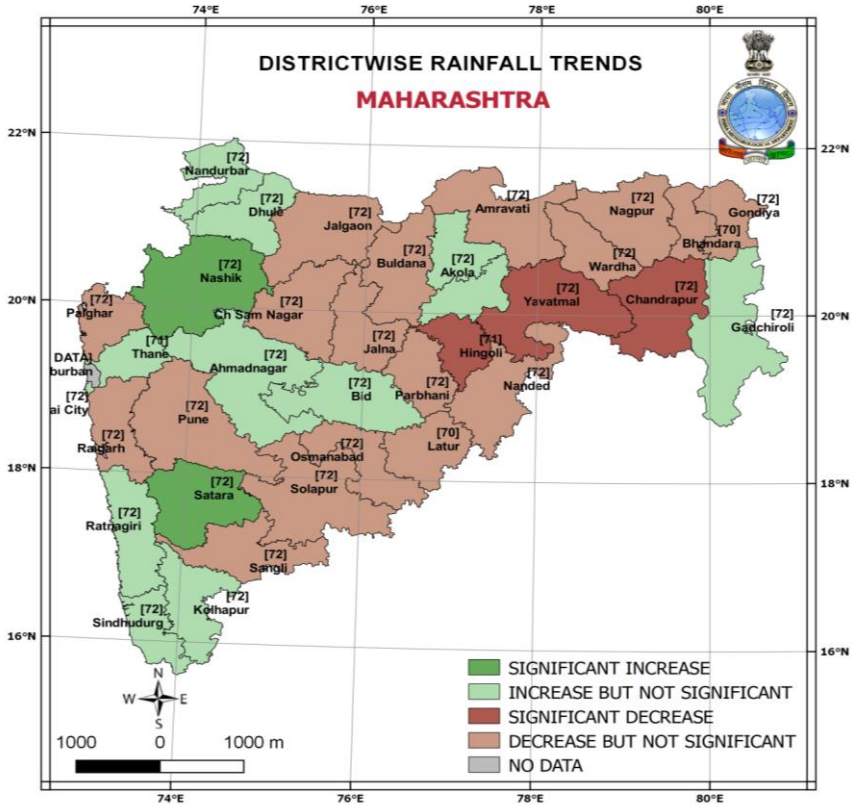


Fig. 7: District-wise annual rainfall Trend for Maharashtra
[Numbers in the bracket for each district indicates the number of years up to 2022 used to calculate the trend]

Standardized Precipitation Index (SPI)

The district-wise annual SPI Map for the state for the year 2024 is shown in **Fig. 8**. The SPI, is based on precipitation, serves as a measure of drought. This index yields negative values for drought and positive values for wet conditions. As the wet and dry conditions become severe, the index becomes more positive or negative . Mildly wet to moderately wet conditions were observed across many districts of the state. In contrast, severely wet conditions were observed in two adjoining northern districts (Nashik and Jalgaon) and two southern districts (Sindhudurg & Kolhapur). However, Satara and Hingoli districts experienced mildly dry and severely dry conditions respectively.

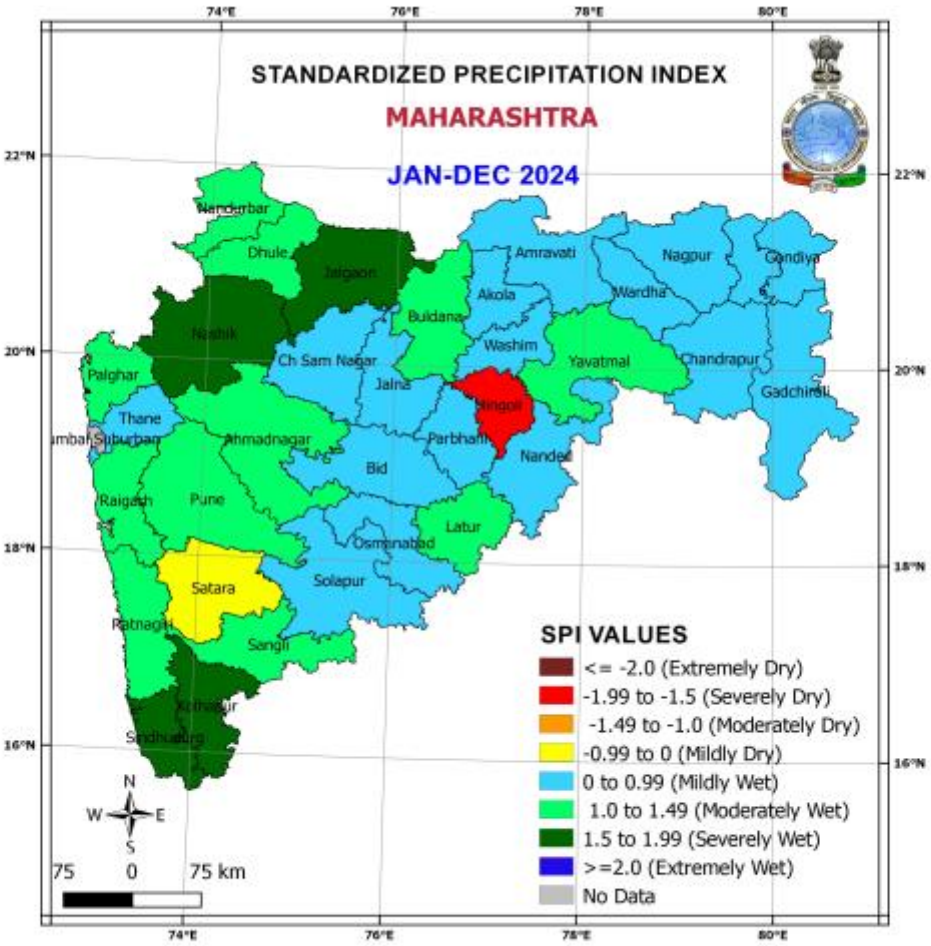


Fig. 8: District wise Annual SPI Map for Maharashtra for the year 2024

Extreme Weather Events

Heavy (rainfall between 64.5-115.5mm), very heavy (115.6-204.4 mm) and extremely heavy (>= 204.5 mm) rainfall events were recorded over some stations of Maharashtra during 2024. **Fig.9** shows the location and frequency of occurrence of such events during the year. **Table 2** shows the extremely heavy rainfall values with the date of its occurrence and the locations.

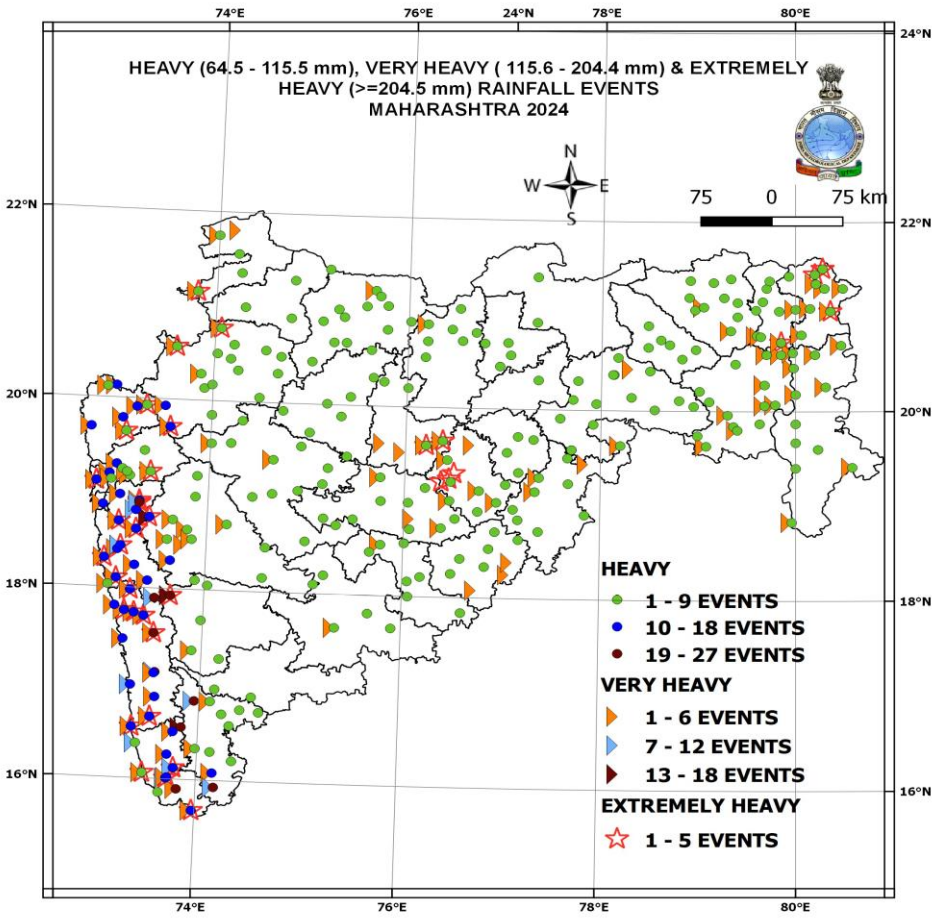


Fig. 9: Location and frequency of heavy , very heavy and extremely heavy rainfall events reported over stations of Maharashtra during the period January to December 2024

Table 2

Extremely heavy rainfall # (> 204.4 mm) events recorded over stations of Maharashtra during January – December 2024

DATE	STATION NAME	RAINFALL (mm)
09-Jun	MULDE_ AGRI	223.6
21-Jun	DODAMARG	215.0
22-Jun	MANDANGAD	205.0
07-Jul	MATHERAN	220.0
08-Jul	SANTACRUZ - IMD OBSY	267.9
	MHASLA	273.0
	MURUD	255.0
	TALA	287.0
	RAJAPUR	230.0
	WAKWALI_AGRI	251.0
	AWALEGAON - ARG	377.5
	DODAMARG	305.0
	KUDAL	235.0
	MALVAN	214.0
	MULDE_ AGRI	244.8
	RAMESHWAR_AGRI	255.0
09-Jul	MHASLA	227.0
	MURUD	215.0
	DAPOLI_AGRI	231.0
	MALVAN	230.0
14-Jul	MATHERAN	216.0
	PEN	221.0
	SUDHAGAD PALI	217.0
	TALA	208.0
	MANDANGAD	205.0
	MURBAD	256.0
	WADA	207.0
	LONAVALA_AGRI	241.5
15-Jul	CHIPLUN	243.0
	KHED	212.0
	MANDANGAD	210.0
	WAKWALI_AGRI	223.2
19-Jul	AWALEGAON - ARG	264.5
20-Jul	PEN	210.0
	LAKHANDUR	241.5
21-Jul	DAPOLI_AGRI	225.0
	MANDANGAD	205.0
22-Jul	RAJAPUR	210.0
	MAHABALESHWAR- IMD OBSY	241.0
24-Jul	LONAVALA_AGRI	275.4
25-Jul	KARJAT_AGRI	231.2
	MATHERAN	233.0
	DAPOLI_AGRI	214.0
	MOKHEDA - FMO	280.9
	MURBAD	228.0
	IGATPURI	217.0
	MULHER - FMO	280.9
	LONAVALA_AGRI	351.6
	MAHABALESHWAR- IMD OBSY	330.1
26-Jul	KARJAT_AGRI	268.2
	NAVAPUR	220.0
	LONAVALA_AGRI	243.0
	MAHABALESHWAR- IMD OBSY	279.6
04-Aug	MATHERAN	293.0
	IGATPURI	240.0
	LONAVALA_AGRI	236.6
24-Aug	MULDE_ AGRI	206.0
26-Aug	SURGANA	240.0
02-Sep	MANTHA	235.0
	PARTUR	220.0
	DHALEGAON - FMO	260.9
	MANVAT	307.0
	PATHRI	229.0
10-Sep	DEORI	210.3
	GONDIA	207.9
	GONDIA AP	285.4

(#: Rainfall figures are for past 24 Hrs. ending on 8:30 Hrs. IST of the date)

The locations impacted by major extreme weather events in Maharashtra during the year 2024 is shown in **Fig 10**. The state experienced flood/heavy rain, heatwave, lightning/thunderstorms, gale and hailstorm events during the year.

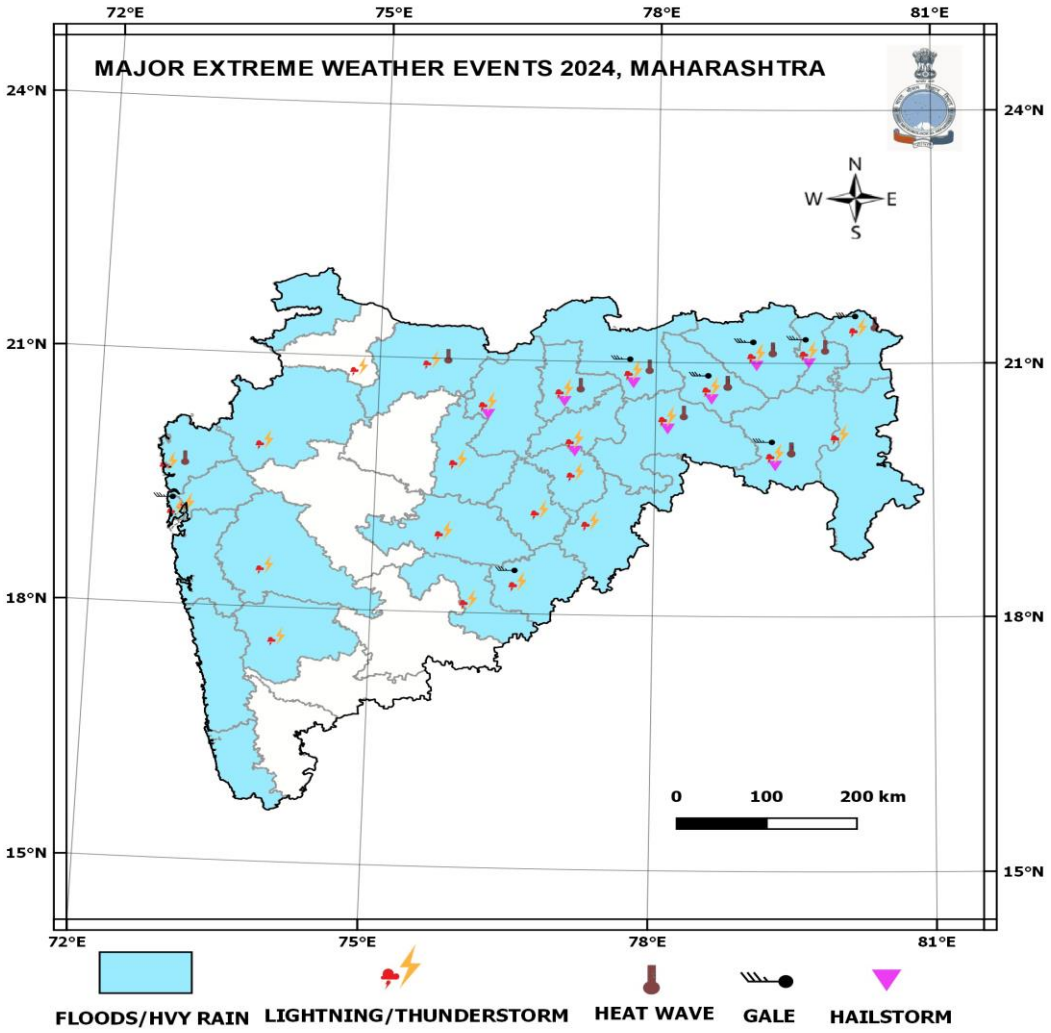


Fig. 10: Locations impacted by major extreme weather events in 2024
(details provided in the Table 3)

Table 3

Major extreme weather events during 2024which caused loss of human lives*
in Maharashtra

Event	Number of casualties and Date	Season	Affected districts
Lightning and Thunderstorm	**84** (10, 13, 15, 22, 29 Apr.; 9, 11, 12, 13, 19, 21, 25, 26 May; 1 to 11, 14, 21 Jun.; 2, 8, 10, 18, 19, Jul.; 14, 18, 22, 29 Aug.; 20, 23 to 26 Sep.; 19 Oct.)	Pre-Monsoon (March to May), Monsoon (June to September), Post-Monsoon (October to December)	Akola, Amaravati, Beed, Bhandara, Buldhana, Chandrapur, Dharashiv/Osmanabad, Dhule, Gadchiroli, Gondia, Hingoli, Jalana, Jalgaon, Latur, Mumbai Suburban, Nagpur, Nanded, Nashik, Parbhani, Pune, Satara, Thane, Wardha, Washim, Yavatmal
Floods and Heavy Rain	**64** (15 May; 1 to 7, 9, 10, 11 Jun.; 14, 18, 20, 21, 24, 25, 27, 28, 29 Jul.; 8 Aug.; 2, 9, 15, 25, 26, 27 Sep.)	Pre-Monsoon (March to May) Monsoon (June to September)	Akola, Amaravati, Bhandara, Buldhana, Chandrapur, Gadchiroli, Gondia, Jalana, Jalgaon, Latur, Mumbai City, Mumbai Suburban, Nagpur, Nanded, Palghar, Parbhani, Pune, Raigad, Ratnagiri, Sindhudurg, Thane, Wardha, Washim, Yavatmal
Heat Wave	**28** (17 Apr.; 5, 24, 26, 27, 29, 30, 31 May)	Pre-Monsoon (March to May)	Akola, Amaravati, Bhandara, Chandrapur, Gondia, Jalgaon, Nagpur, Palghar, Wardha, Yavatmal
Hailstorm	**2** (18 Mar.; 23 Apr.)	Pre-Monsoon (March to May)	Buldhana, Yavatmal
Gale	**1** (26 May)	Pre-Monsoon (March to May)	Latur

*(*: Based on the media reports and the reports from Disaster Management Authorities of the government)*

Summary

The Statement on Climate for the state of Maharashtra for 2024 is prepared based on the real-time meteorological observation across the state at the district/block level in different seasons and taking reference of more than 100 years of past climate data for the state. So, the observation made in this report are very important for different sectors like agriculture, health, power, disaster management and water, etc. This joint report is prepared by the India Meteorological Department with the crucial inputs from the state government, which we expect in future as well. It is suggested that with the demanding need at global and regional level related to the climate change for sustainable development, this type of joint reports/ventures would be a path breaking for the society. By saying so, following are the submitted:

(i) The report may please be circulated to all the concerned ministries/departments of the state government and other relevant stakeholders in the state.

(ii) Based on the feedback, further course of actions in different climate sectors can be planned, like holding workshops, pilot studies, and any other joint ventures.

Apart from this annual climate statement, India Meteorological Department, Pune comes out regularly with climate updates which are shared on the public domain for the users' benefit. It is suggested to check for these updates regularly on the India Meteorological Department (IMD), Pune website: : https://www.imdpune.gov.in/.

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