

Detailed Methodology for Mumbai Rainfall Spot Calculation

1. Summary

This note outlines the complete methodology, data sources, spot-price construction process, and contract mechanics for the proposed Mumbai rainfall-based weather derivative. The contract settles on the monthly cumulative deviation from the Long Period Average (LPA), calculated using daily rainfall observations from IMD's Colaba and Santacruz stations, obtained through an authenticated API feed.

The product is designed as a cash-settled futures contract, where settlement is based on the spot value - cumulative deviation for the relevant month - arrived from actual rainfall value provided by IMD. The last trading day of the futures contract is the business day immediately preceding the last calendar day of the month. The expiry day of the futures contract will be on the calendar day immediately following the last trading day.

2. Parameter for proposed derivative

- The proposed weather parameter for the contract is Rainfall.

3. How rainfall is defined on any particular day

- Rainfall is measured using rain gauges or automatic weather stations (AWS) installed at specific locations; therefore, rainfall represents the precipitation recorded at that exact location. For example, "rainfall at Colaba Station or rainfall over Colaba Station" refers to the measurement captured by the Colaba rain gauge installed at Colaba station of Indian meteorological department (IMD) or any other exchange specified agency.
- The standard unit of rainfall measurement is millimeters (mm), which basically represents the depth of water collected in the gauge.
- Rainfall for any given day is defined as the total cumulative rainfall measured during the 24 hour period ending at 8:30 am on that day. For instance, the rainfall for June 5, 2025 is the accumulated rainfall recorded from 8:30 am on June 4, 2025 up to 8:30 am on June 5, 2025.
- Note: Even if a portion of the 24 hour period falls on the previous calendar day, the entire 8:30 am–to–8:30 am measurement is attributed to the current day's rainfall value as per IMD standards.

4. Details of Basis Centre

• Basis Centre – Mumbai
• Stations used for Spot calculation – Colaba and Santacruz

5. Data types used and definition

- **Surface Rainfall Observation:** Rainfall is measured following World Meteorological Organization (WMO) standards and recorded manually by IMD officials using calibrated, standardized

instruments. Observations are taken every three hours during the synoptic hours between 08:30 AM and 08:30 AM of the next day (total of eight observations), which are then aggregated to arrive at the daily rainfall total as defined earlier (*refer point no. 3*).

- **Automatic Weather Stations (AWS) Observations:** Rainfall intensity is captured automatically through AWS instruments. Measurements are recorded at 15-minute intervals (96 observations per day) and subsequently cumulated to derive the daily rainfall amount.
- **Data Used for Contract Settlement and Spot Construction:** For both contract settlement and daily spot-value updation, NCDEX will use Surface Rainfall Observation data, given its higher reliability, longer historical availability, and recognized acceptance in meteorological and research standards.
- **Use of AWS Observations for Transparency:** AWS rainfall data will be displayed on the NCDEX website as part of the real-time information dissemination process, helping participants track intra-day rainfall trends.
- **Fallback Mechanism:** AWS data will serve as a fallback input in situations where Surface data is delayed, temporarily unavailable, shows discrepancies or requiring validation. Exchange may also onboard additional agency/ agencies for rainfall data to be used as additional fallback mechanism in case both surface and AWS data is delayed, temporarily unavailable, shows discrepancies or requiring validation. Exchange will inform the trade participants regarding onboarding of any such additional agency/ agencies for obtaining rainfall related data.
- **Data Acquisition and Frequency:** Both Surface and AWS observations will be fetched through API feeds from the IMD data server. Surface data will be accessed once daily, whereas AWS data will be fetched at 15-minute intervals or higher frequency in line with its measurement frequency.

1. Long Period Average (LPA) or Normal

- **Long Period Average (LPA)** refers to IMD's climatological normal computed over a **30-year reference period (currently 1991–2020)**. LPA is calculated **separately for each station/location** and also for each day which denotes the **expected or climatologically normal rainfall for each calendar day at that location**, expressed in millimeters.
- **For example**, the LPA for **1 June at IMD Colaba** is derived by averaging the rainfall recorded on **1 June for each year from 1991, 1992, ... up to 2020**. This approach ensures consistency in long-term climate comparison.

2. Mumbai Rainfall Spot Calculation

- Mumbai rainfall spot is calculated using the following inputs:
 - Daily Long period average (LPA) rainfall for Mumbai location
 - Daily actual rainfall for Mumbai location during current year
 - Calculation of daily Rainfall deviation during Monsoon season (1 June to 30 September**)

a. Calculation of Mumbai Daily Long Period Average (LPA_Mumbai_Date1)

- For Mumbai rainfall daily spot calculation, Long Period Average (LPA) of both Colaba and Santacruz Stations will be used.
- Mumbai Daily LPA (LPA_Mumbai_Date1) for particular date (say Date1) = $(\text{LPA_Colaba_date1} + \text{LPA_Santacruz_date1}) / 2$ i.e. average LPA of these two stations. The Mumbai daily LPA will be used for defining normal rainfall/ LPA on particular date for Mumbai location spot calculation.
- Mumbai Monthly LPA = Sum of Mumbai daily LPA for that month. For example: Monthly LPA for June month will be sum of Daily LPA from 1 June to 30 June.
- Mumbai Monsoon Season LPA = Sum of Mumbai daily LPA from 1 June to 30 September**.
- Based on IMD data, Mumbai Monsoon Season LPA is **2206.7 mm**.

b. Calculation of Mumbai Daily Rainfall (Rain_Mumbai_Date1)

- Mumbai Daily Rainfall (Rain_Mumbai_Date1) for a particular date (say Date1) = $(\text{Rain_Colaba_date1} + \text{Rain_Santacruz_date1}) / 2$ i.e average Rainfall of these two stations.

c. Mumbai Daily Deviation calculation (Deviation_Mumbai_Date1)

- Mumbai Daily Deviation (Deviation_Mumbai_Date1) = $\text{Rain_Mumbai_Date1} - \text{LPA_Mumbai_Date1}$
- Positive deviation = excess rainfall then LPA on that day; Negative deviation= deficit rainfall than LPA on that day)

d. Spot Calculation – Daily Deviation Model

- Mumbai rainfall Spot will measure the deviation of actual rainfall on a given day with the LPA rainfall on that day. The deviation will be calculated starting from June 01 every year.
- The starting point (also known as anchor point) on day zero for Mumbai rainfall spot will be the Mumbai Monsoon Season LPA (i.e 2206.7)**.
- **This anchor point will remain unchanged in case the last trading day futures contract of September month is immediate preceding to the last calendar day in a particular year. In case, last trading day is not immediate preceding to the last calendar day, then LPA (anchor point) will be revised based on LPA values from June 01 till calendar day immediately following the last trading day of the September month futures contract.*

Example

	30-Sep	29-Sep	28-Sep	27-Sep	Last Trading Day	Due Day / Expiry Day	LPA Period
Case 1	Holiday	Trading Day	Trading Day	Trading Day	29-Sep	30-Sep	1 Jun - 30 Sep
Case 2	Trading Day	Holiday	Trading Day	Trading Day	28-Sep	29-Sep	1 Jun - 29 Sep

Case 3	Trading Day	Trading Day	Holiday	Trading Day	29-Sep	30-Sep	1 Jun - 30 Sep
Case 4	Holiday	Holiday	Trading Day	Trading Day	28-Sep	29-Sep	1 Jun - 29 Sep
Case 5	Trading Day	Holiday	Holiday	Trading Day	27-Sep	28-Sep	1 Jun - 28 Sep
Case 6	Trading Day	Trading Day	Holiday	Holiday	29-Sep	30-Sep	1 Jun - 30 Sep
Case 7	Holiday	Holiday	Holiday	Trading Day	27-Sep	28-Sep	1 Jun - 28 Sep

- From June 01, daily spot will be calculated by adding the Mumbai daily rainfall deviation to the starting point. Subsequently, each day's deviation will be added to the previous days value.

Illustration of Spot updation - daily

Date	Mumbai Daily LPA (mm)	Mumbai Daily Rainfall (in mm)	Mumbai Daily Deviation (mm)	Spot for the day
	-	-	-	2,206.70
1-Jun	8.7	0.00	-8.7	2,198.00
2-Jun	3.7	0.00	-3.70	2,194.30
3-Jun	6.0	0.00	-6.00	2,188.30
4-Jun	4.8	5.22	0.42	2,188.72
5-Jun	8.9	0.47	-8.43	2,180.29
6-Jun	5.1	0.65	-4.40	2,175.88
7-Jun	7.1	0.73	-6.32	2,169.56
8-Jun	12.7	5.87	-6.78	2,162.78
9-Jun	18.4	14.12	-4.23	2,158.54
-	-	-	-	-
-	-	-	-	-
28-Jun	22.8	66.66	43.91	2,119.54
29-Jun	24.2	53.13	28.93	2,148.48
30-Jun	26.3	22.44	-3.81	2,144.67 - Used as FSP for June expiry contract

1-Jul	25.6	23.59	-2.01	2,142.66
2-Jul	37.0	36.76	-0.24	2,142.42
3-Jul	30.3	4.64	-25.66	2,116.76
4-Jul	44.3	5.66	-38.64	2,078.12
5-Jul	38.6	16.17	-22.38	2,055.74
6-Jul	19.9	23.24	3.39	2,059.14

Spot behavior on change of month

- During the transition from one month to the next (e.g., June to July), the cumulative rainfall deviation up to the last calendar day of the previous month will be carried forward. Accordingly, the closing spot value on 30 June becomes the opening spot value for 1 July, ensuring continuity in the cumulative deviation series. (Refer above illustrative table)

Spot updation cycle

- As per IMD and WMO standards, the daily rainfall for any given day is defined as the total precipitation recorded over the preceding 24 hours ending at 08:30 AM. Accordingly, the actual rainfall data for both stations will be made available to the Exchange through the API feed at approximately 09:00 AM each day, prior to the commencement of trading.
- Consequently, the daily spot value will be updated by around 09:15 AM on every trading day, based on the latest rainfall data received through the official API mechanism from IMD.
- The spot value will be updated only once per day on the trading platform, and the same value will remain unchanged for the entire trading session.

Since the rainfall deviation is calculated for each calendar day of the month, the cumulative deviation for non-trading days will be incorporated into the spot value during the next spot-update cycle. Accordingly, the spot published on the next business day will reflect the aggregated deviation for all intervening non-trading days.