Indian Precipitation Experiment (IPEx) :
Unravelling the contrasting microphysical features of rainfall characteristics over India

by

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**Indian Precipitation Experiment (IPEx) :
Unravelling the contrasting microphysical features of
rainfall characteristics over India**

Rohit Patil, IITM, Pune
Gargi Rakshit, IMD New Delhi
Ambuj Jha, IITM, Pune
Harikrishna Devisetty, IITM, Pune
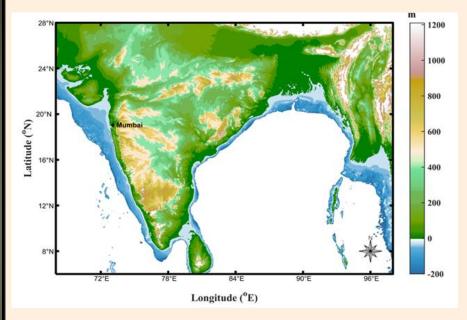G.Pandithurai, IITM, Pune

Some Glimpses of what has been done for the last 2-3 years

Rainfall Microphysics over Mumbai : an urban-coastal city of India

One of the densely populated urban coastal cities of the world

The financial and commercial capital of India
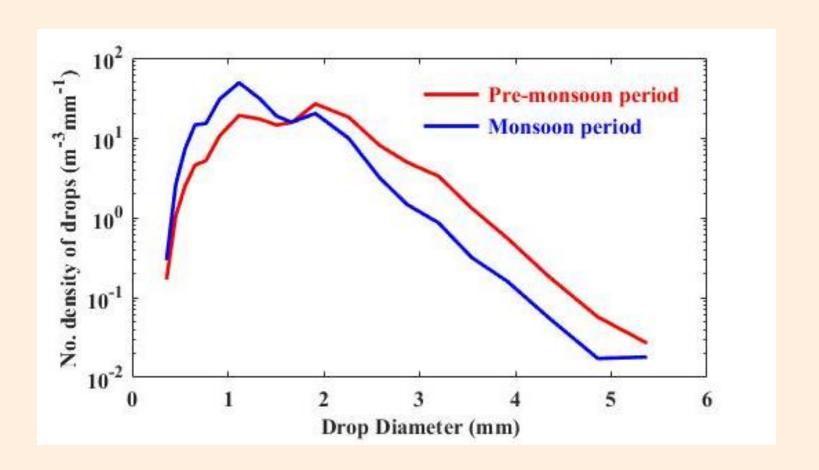
Average total annual rainfall = 2500 mm
The maximum annual rainfall ever recorded was = 3,475 mm (2019)

The highest rainfall recorded in a single day was 944 mm on 26/07/05
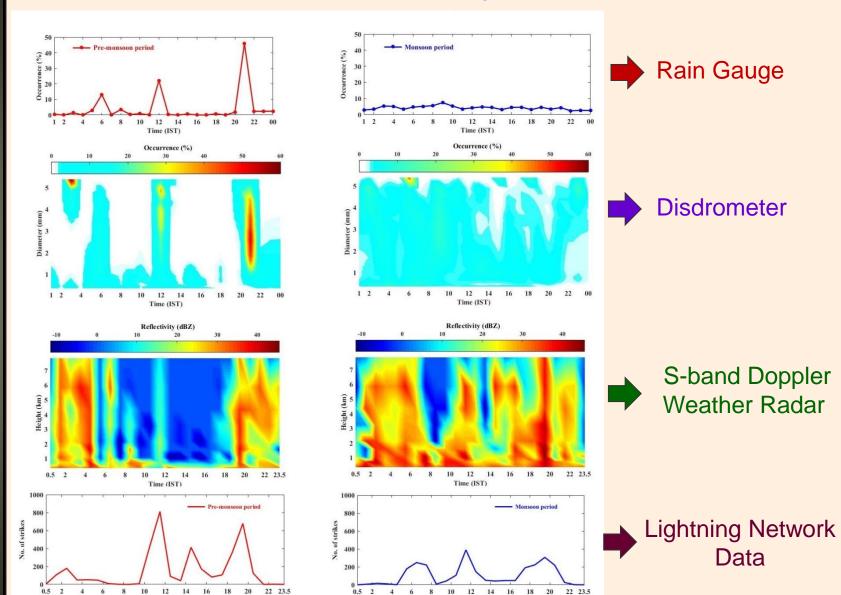
Rainfall Microphysics over Mumbai : an urban-coastal city of India

Variation of raindrop size distribution during the pre-monsoon and monsoon period
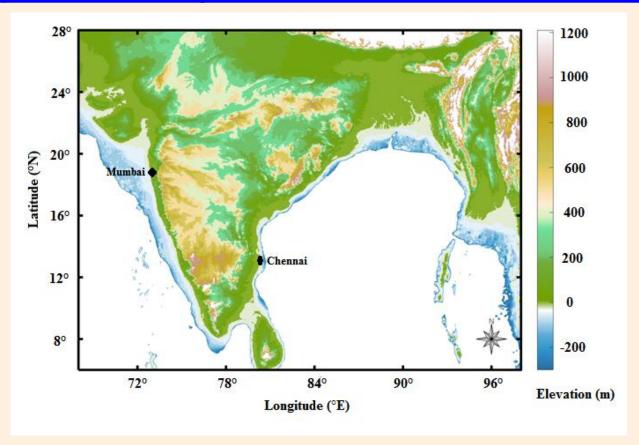
Results of collocated observations (pre-monsoon and monsoon)

Rain Gauge

Disdrometer

S-band Doppler Weather Radar
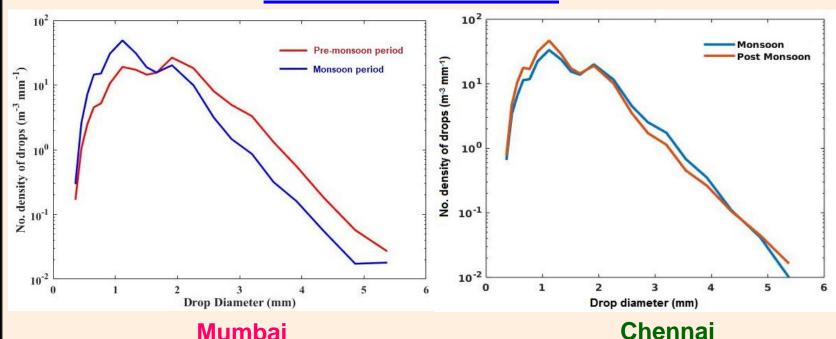
Lightning Network Data

Comparative study of Mumbai and Chennai rainfall

The city of Chennai also receives Extremely Severe rainfall during the period of October – December which are known as North-east monsoon rainfall
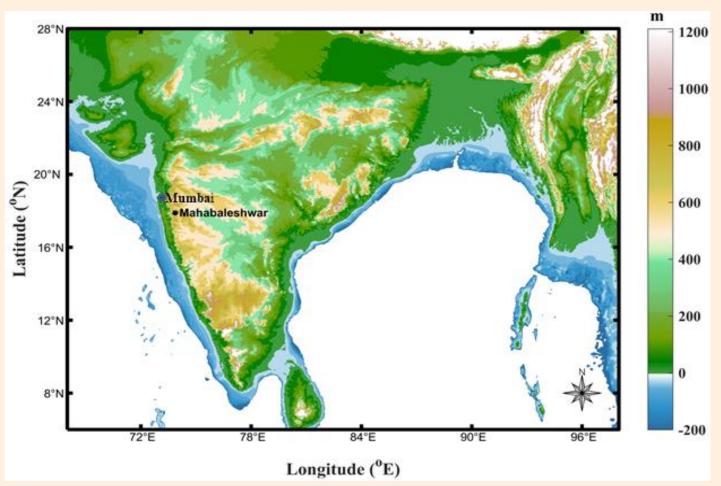
Comparative study of raindrop size distribution of Mumbai and Chennai

Mumbai   **Chennai**

For Mumbai – Raindrops of diameter 1.5 mm and above dominates the pre-monsoon period with respect to monsoon months (Representative Year = 2018)

For Chennai – Although no such distinct variations are visible, but there is a trend of the domination of higher amount of drops in the diameter range of 2-4 mm in the monsoon period and drops in the diameter range of 5 mm and above during the post-monsoon months (Representative Year = 2019)
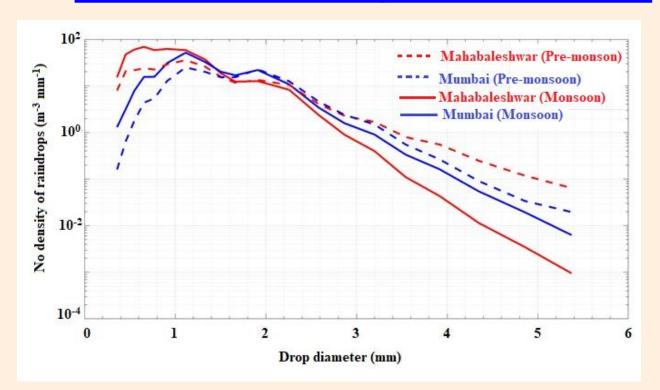
Rainfall Microphysics over Mumbai (Coastal) and Mahabaleshwar (Orographic) station

Annual Rainfall of Mumbai : 2500 mm

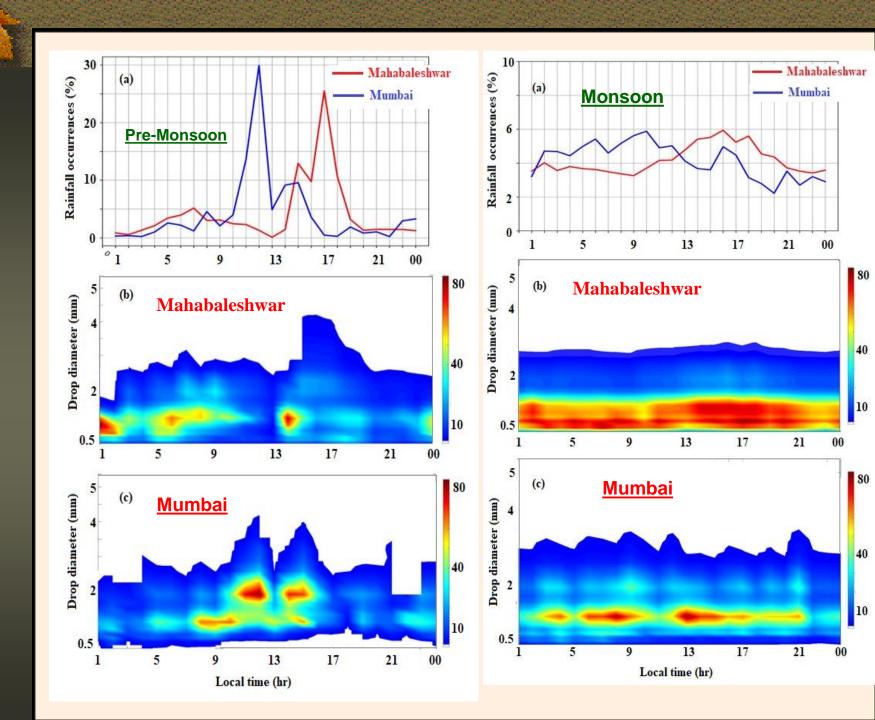**Annual Rainfall of Mahabaleshwar** : 6000 mm
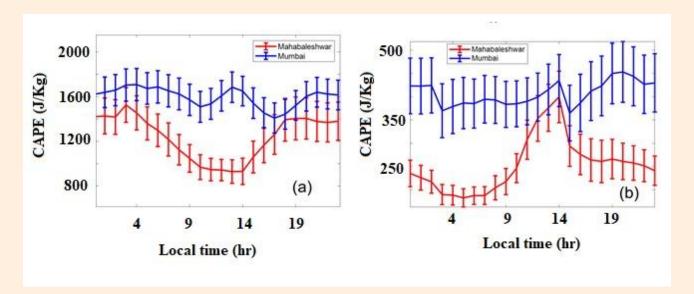
Variation of Raindrop size distribution

An interesting thing happens over this analysis :

- During pre-monsoon period, raindrops of diameter 1.5 mm and above is seen to be dominated for the Mahabaleshwar rainfall with respect to the Mumbai one.
- While the opposite behaviour is seen in the monsoon period when the domination of Mumbai rainfall is seen to be more with respect to Mabaleshwar rainfall for raindrops of diameter 3 mm and above

Pre-Monsoon

Monsoon

Mahabaleshwar

Mahabaleshwar

Mumbai
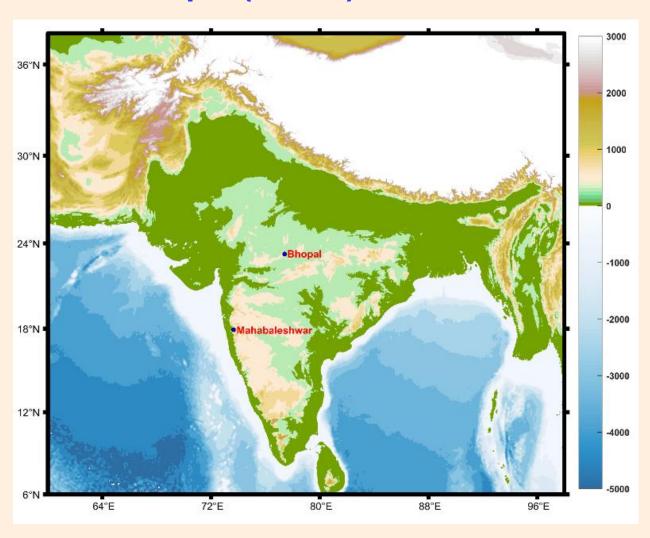
Mumbai

Diurnal variation of CAPE

The variation of Convective Available Potential Energy (CAPE) provides a strong impact on the Diurnal variation of precipitation

The initial analysis shows that the value of CAPE is much more during the Pre-monsoon period with respect to monsoon months

The increase of CAPE is seen over Mumbai during 09-12 hrs while the Increase in CAPE over Mahabaleshwar is observed from 15-19 hrs – all during the pre-monsoon period
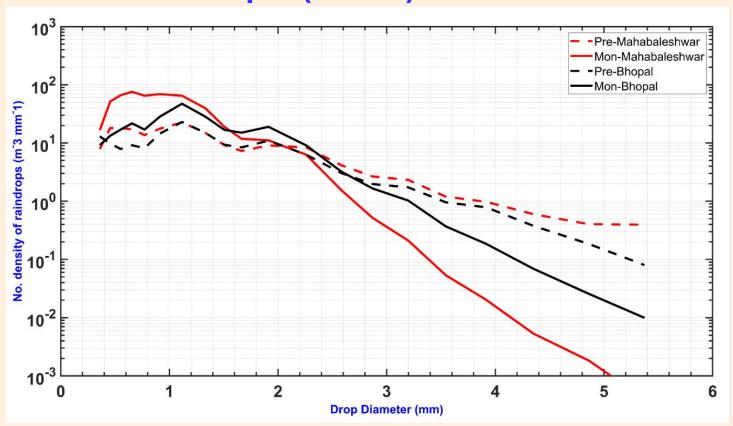
The similar observation is also observed for the diurnal pattern of rainfall Variation for both the cities during the pre-monsoon period.

Rainfall Microphysics over Mahabaleshwar (orographic) and Bhopal (Inland) station of India

Rainfall Microphysics over Mahabaleshwar (orographic) and Bhopal (Inland) station of India

Variation of raindrop size distribution during the pre-monsoon and monsoon period over Mahabaleshwar and Bhopal

What has been done

Details microphysical features of rainfall has been studied w.r.t

The inter-seasonal phases of monsoon over the 2 urban coastal cities of India – i.e Mumbai and Chennai
Atmospheric Res, 2021

The various stages of Cyclone Nisarga over the orographic Region of Mahabaleshwar
Atmospheric Res, 2021

The inter-seasonal phases of monsoon over Bhopal and *Mahabaleshwar – i.e the stations representing the Orographic and Inland stations of India*
(The first result has been presented in IRAD-2025)

The inter-seasonal phases of monsoon over the urban city of Mumbai
Natural Hazard, 2021

The inter-seasonal phases of monsoon over Kolkata and *Thiruvananthapuram – i.e the stations representing along the monsoon track*
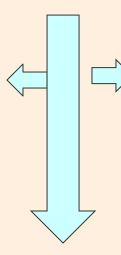*JASTP, 2021*

The inter-seasonal phases of monsoon over Mumbai and *Mahabaleshwar – i.e the stations representing the coastal and orographic stations of India*
JASTP, 2023

What has been done

Details microphysical features of rainfall has been studied w.r.t

Rainfall associated with and Without Lightning
JESS, 2020

Contrasting features of Rainfall associated With a Thunderstorm and Cyclone
JESS, 2025 (Under review)

Several studies are going on all over India with respect to raindrop size distribution in the regional scale

What is Missing

A Comprehensive Analysis of Raindrop size distribution
over the regions of India
which
differ widely with respect to their
Geographical and Climatic Variations

Disdrometer Network over India

IITM, Pune has established the Network of Disdrometers over various regions Of India which differ widely with respect to their geographical and climatic variations

1. New Delhi
2. Mumbai
3. Kolkata
4. Chennai
5. Pune
6. Mahabaleshwar
7. Kochi
8. Bhopal
9. Silkheda
10. Lakshadweep Island
11. Agumbe
12. Port Blair
13. Dharamshala
14. Itanagar
15. Solapur
16. Turjapur
17. Guwahati

Disdrometer Network over India

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These installation will highlight the microphysical features of rainfall over

(i) The major Metro cities of India like

New Delhi
Mumbai
Chennai
Kolkata

(ii) The Island stations of India like

Port Blair
(over Bay of Bengal) &
Lakshadweep
(over Arabian Sea)

Disdrometer Network over India

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(iii) The Western and Eastern Himalayan stations at Dharamshala & Itanagar

(iv) The severe rainfall stations at Kochi

(v) The urban and rural station of Central India separated by 50 km Bhopal & Silkheda

Disdrometer Network over India

IITM, Pune has established the Network of Disdrometers over various regions Of India which differ widely with respect to their geographical and climatic variations

(vi) **Orographic station of Western Ghat at**

Mahabaleshwar

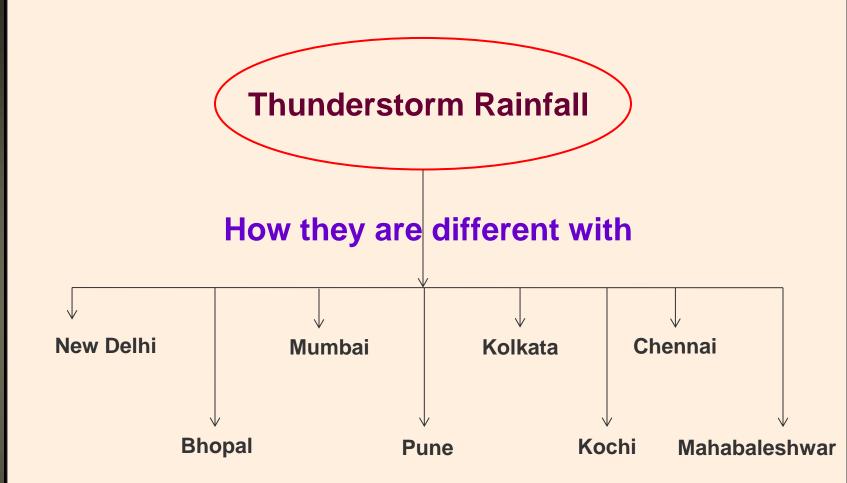(vii) **Stations at the Leeward side of Western Ghat at**

Pune, Solapur, Turjapur
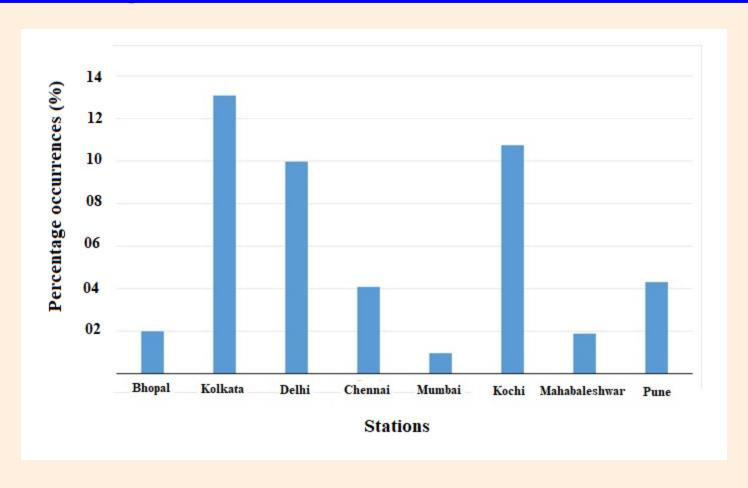
(viii) **City at the North-eastern part of India at**
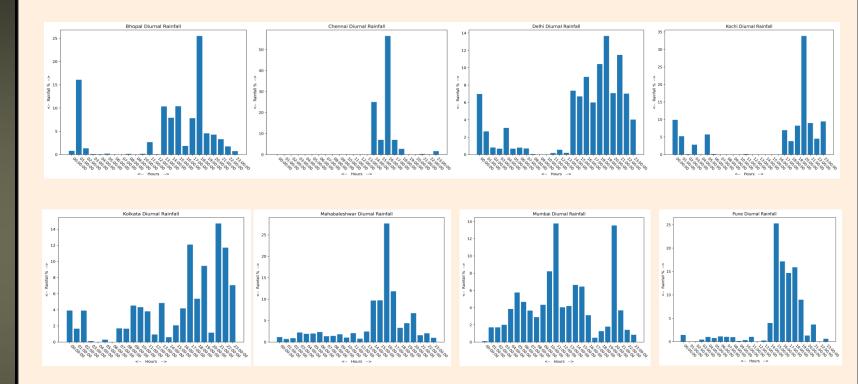
Guwahati

As a small step of what we had done….

Thunderstorm Rainfall

How they are different with

New Delhi   Mumbai   Kolkata   Chennai

Bhopal   Pune   Kochi   Mahabaleshwar

Percentage Occurrences of Thunderstorm Rainfall
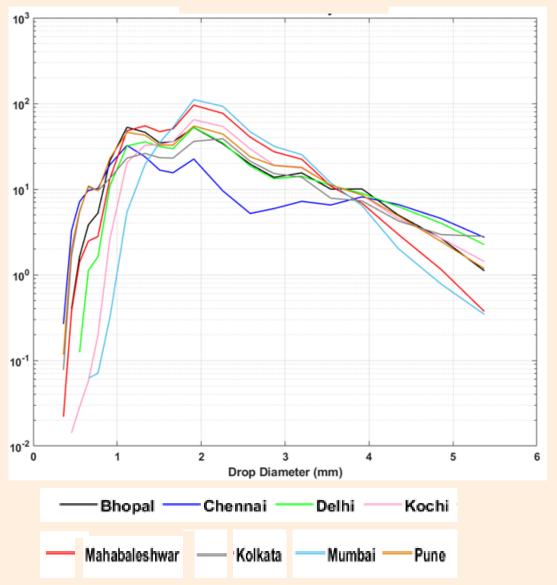
Diurnal Variation of Rainfall

It is clearly seen from the figure that most of the rainfall in the pre-monsoon period occurs during the afternoon hours
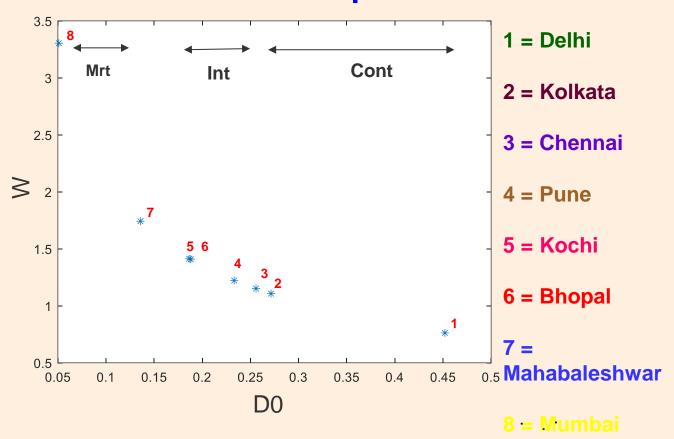
Variation of Raindrop size distribution over these 8 Stations

It is clearly visible from the figure that the raindrops of larger diameter dominates more over Chennai and Delhi with respect to Mumbai.

Liquid water content Vs Mean Volume Diameter relationship

1 = Delhi

2 = Kolkata

3 = Chennai

4 = Pune

5 = Kochi

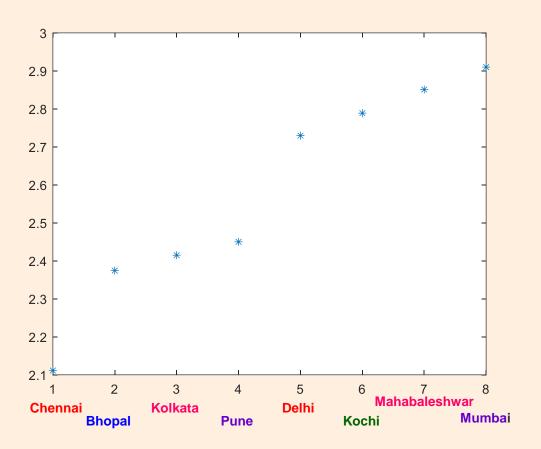**6 = Bhopal**

7 = Mahabaleshwar

8 = Mumbai

The Liquid Water Content (W) vs median volume diameter (D0) relationship for rain rate = 30 mm/h

It is clearly visible that D0 decreases for more maritime clouds.

Z-R relationship for fixed dBz

The Z-R relations for rainfall from Maritime to Continental clouds. The rain intensities for 30 dBz has been plotted in the figure

The systematic increase of Rain intensity for a given Z for the transition from Continental to Maritime clouds are visible

What we Propose...

A coordinated field campaign with the presently available Disdrometers at different sectors in India for 4 years (2025 – 2028)

The main objective of this field campaign is to enhance the understanding of microphysical characteristics of terrestrial precipitation over diverse hydroclimatological conditions for improved predictions and disaster mitigation.

What we gain…

**This will be for the first time will highlight the contrasting microphysical features of Indian monsoon
in different time scale simultaneously
over various regions of India**

**This will also be a part of Monsoon Campaign of IITM / MoES
from 2025**

Can be a part of Any other Monsoon Program ……??

As this is happing by taking into account of various regions of India

hence

I coined the term

Indian Precipitation Experiment (IPEx)

and Put it in the Heading

Acknowledgement

Ministry of Earth Sciences
Government of India

Director, IITM, Pune

India Meteorological Department
of Mumbai, Chennai ,
New Delhi, Kolkata,

Organizing Committee of
IWM-2025

Thank You