

Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone Meenu R Nair

Indian Institute of Tropical Meteorology (IITM), Pune

Email contact: meenurnair4@gmail.com

1.Introduction

4. Results & Discussion

The Indian Summer Monsoon (ISM) core zone is characterized by the establishment of inter tropical convergence zone (ITCZ) during the end of onset of ISM. Boreal northward migration of ITCZ pushes the subtropical jet further north above the Himalayan foothills during the monsoon period. Observations of environment vertical structures of turbulence, atmospheric parameters, stability parameters, and cloud vertical structure over Bhopal in Central India, a vital core monsoon zone, can bring new insights on predictability. ISM understanding and better Turbulence in the atmosphere can be parameterized by the refractive index structure parameter (C_n^2) which depends on humidity and temperature profiles.



2. Objectives

- Explore seasonal VST features at a tropical site in Central India (CI), Bhopal, for the first time.
- 10 years of radiosonde(GPS-RS) dataset is utilized to examine seasonal, annual, and intra-annual variations of C_n^2 and its footprint on the onset, withdrawal, and seasonal variability of ISM in light of the other prognostic parameters.
- Investigate how the estimated C_n^2 profiles are helpful in providing necessary information for the proposed wind profiling radar experimental specifications at the testbed facility.
- The study also aims to unravel the typical fluctuations in VST / C_n^2 under different synoptic



Fig.3 *CFAD panels shows VSC over CI during a) active and b)* break ISM from Cloudsat

• The observed higher cold cloud fraction corroborates well with the weakest turbulence ($<10^{-17}$ m^{-2/3}) zone centered around 14 km altitude over Bhopal during the monsoon season.

• $C_n^2 < 10^{-17} \text{ m}^{-2/3}$ zone can be a precursor for the ISM onset and vigor in the monsoon core zone

• The presence of strong turbulence up to 12 km altitude strongly couples with the frequent presence of warm moist monsoon convection and hence the clouds during JJAS

weather conditions.

3. Study area, Data & Methodology



Data used- radiosonde data Bhopal by India Meteorological Department (IMD) for 10 years, January 2011 to May 2020, ERA5, IMD gridded

• The warm and rich moisture conditions are conducive for convective instabilities..



Fig. 5. Daily mean composite of (a) Temperature (T) (b) relative humidity (RH) (c) wind (d) surface T and RH (e) CAPE, CIN and precipitable water

5. Summary & Conclusions

• The observed higher cold cloud fraction corroborates well with the weakest turbulence centered at 14 km

• A flip-flop pattern of mid-tropospheric wind from non-monsoon to monsoon holds the key for ISM vigor over

rainfall data

Methodology; $C_n^2 = a^2 \alpha' L_0^{4/3} M^2$ М $= -77.6 X \, 10^{-6} \frac{p}{T} \frac{\delta ln\theta}{\delta z} \left[1 + \frac{15500q}{T} \left(1 - \frac{1}{2} \frac{\delta lnq/\delta z}{\delta ln\theta/\delta z} \right) \right]$

the monsoon core zone.

- The homogeneous rich moisture and tri-model cloud vertical structure explain the less variance during monsoon season.
- The large turbulence values below 12 km during monsoon are due to the frequent convective instabilities and higher vertical velocities.

Acknowledgments IITM is an autonomous organization that is fully funded by MOES, Govt. of India. The authors are thankful to Director, of IITM, for every support and help on this research work. The first author would like to acknowledge her INSPIRE Fellowship of DST References R Nair Meenu, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone." Atmospheric Research(2022): Volume22,106382. https://doi.org/10.1016/j.atmosres.2022.106382 Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud Rolar Meenu W, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, M.C. Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud Main Meenu W, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, M.C. R. Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud Main Meenu W, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, M.C. R. Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud "https://doi.org/10.1016/j.atmosres.2022.106382 Kalapureddy, "https://doi.org/10.1016/j.atmosres.2022.106382		1	Atmospheric Research 279 (2022) 106382	
IITM is an autonomous organization that is fully funded by MOES, Govt. of India. The authors are thankful to Director, of IITM, for every support and help on this research work. The first author would like to acknowledge her INSPIRE Fellowship of DST References R Nair Meenu , K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone." <i>Atmospheric Research</i> (2022): Volume22,106382. <u>Https://doi.org/10.1016/j.atmosres.2022.106382</u> Kalapureddy, M.C.R., Patra, S., Dhavale, V. <i>and Meenu R, Nair.</i> CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	Acknowledgments		Contents lists available at ScienceDirect	
Director, of IITM, for every support and help on this research work. The first author would like to acknowledge her INSPIRE Fellowship of DST References R Nair Meenu, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone." Atmospheric Research(2022): Volume22,106382. Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	IITM is an autonomous organization that is fully funded by MOES, Govt. of India. The authors are thankful to	5-23 A	Atmospheric Research	ATMOSPHEDIC
INSPIRE Fellowship of DST References R Nair Meenu, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone." Atmospheric Research (2022): Volume22,106382. https://doi.org/10.1016/j.atmosres.2022.106382 Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	Director, of IITM, for every support and help on this research work. The first author would like to acknowledge her			RESEARCH
References R Nair Meenu, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone." Atmospheric Research (2022): Volume22,106382. https://doi.org/10.1016/j.atmosres.2022.106382 Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	INSPIRE Fellowship of DST	ELSEVIER	Journal nomepage: www.elsevier.com/locate/atmosres	
R Nair Meenu , K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the troposphere and lower stratosphere of core monsoon zone." <i>Atmospheric Research</i> (2022): Volume22,106382. https://doi.org/10.1016/j.atmosres.2022.106382 Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	References	A. 1 ·		Check for
troposphere and lower stratosphere of core monsoon zone." <i>Atmospheric Research</i> (2022): Volume22,106382. <u>https://doi.org/10.1016/j.atmosres.2022.106382</u> Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	R Nair Meenu, K. Sunilkumar, Ved Prakash Singh, G. Pandithurai, and M. C. R. Kalapureddy. "Atmospheric turbulence characteristics in the	Atmospheric	c turbulence characteristics in the troposphere and lower	updates
https://doi.org/10.1016/j.atmosres.2022.106382 Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	troposphere and lower stratosphere of core monsoon zone." Atmospheric Research(2022): Volume22,106382.	stratosphere		
Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	https://doi.org/10.1016/j.atmosres.2022.106382	R Nair Meenu ^a R. Kalapureddy	^{, p} , K. Sunilkumar ^a , Ved Prakash Singh ^c , G. Pandithurai ^a , M.C. , ^{a, b, *}	
	Kalapureddy, M.C.R., Patra, S., Dhavale, V. and Meenu R, Nair. CloudSat inferred contrasting monsoon intra-seasonal variation in the cloud	^a Indian Institute of Tropic ^b Department of Atmosphe	al Meteorology (IITM), Dr. Homi Bhabha Road, Pashan, Pune 411008, Maharashtra, India	
^c India Meteorological Department, Ministry of Earth Sciences (MoES), Bhopal 462011, India.	vertical structure over Indian regions. Clim Dyn (2023). https://doi.org/10.1007/s00382-022-06643-0	° India Meteorological Dep	artment, Ministry of Earth Sciences (MoES), Bhopal 462011, India.	

IITM RAC meeting 12-13 April 2023, Pune