

*#Corresponding author: Subrat Kumar Panda; Email: <i>subrat.atmos@curaj.ac.in* 



**Subrat Kumar Panda**<sup>1#</sup>, Unashish Mondal<sup>1</sup>, Toru Terao<sup>2</sup>, and Devesh Sharma<sup>1</sup> <sup>1</sup>Department of Atmospheric Science, School of Earth Sciences, Central University of Rajasthan, INDIA <sup>2</sup>Faculty of Education, Kagawa University, JAPAN



# Introduction

- > The model simulates the intense lightning and convective storms that occurred in the north eastern region of India on June 16 and 17, 2022.
- > The Morrison double moment 6-class microphysics scheme and lightning parameterization scheme based on (Price & Rind, 1992) use to simulate cloud-to-ground and intra-cloud (CG:IC) lightning.
- $\succ$  The results have been compared with the lightning datasets obtained from ground observation by IITM-LLN.
- $\succ$  The study demonstrates that the lightning scheme based on 20 dBZ



### Results

**(b)** 



# Study Area & Data



**Fig 1** WRF study domain model **(a)** India (10 Km resolution); **(b)** double nested domain D01-20 Km and D02-10 km resolution over north eastern region for 16 and 17 June 2022; (c) Cloud Brightness Temperature (K) over the India using INSAT-3D (d) accumulated rainfall (24 hours) in mm over India using NASA-GPM datasets (e) WWLLN lightning strokes over India region

**Fig 2** (a) Combined time series graph of IITM-LLN flash count CG (Stroke type = 0):IC (Stroke type = 1) 16 and 17 June over India, (b) 3D plot of lightning stroke height CG:IC 16 June, (c) 3D plot of lightning stroke height CG:IC 17 June



Fig 3 Model simulated lightning hotspot regions over the north eastern region 16 June 2022 (left panel), Model simulated lightning hotspot regions over the north eastern region 17 June 2022 (right panel)



datasets over the India (a) 16 June 2022; (b) 17 June 2022



**Table 1**Data type

Data	Resolution	Туре
NCEP-FNL	0.25 Degree	IC/BC
ERA-5	0.25 Degree	Reanalysis
NASA-GPM	0.1 Degree	Satellite
WWLLN		Ground Obs.

# Methodology

- $\succ$  This study utilised the Weather Research Forecasting (WRF) model with Advanced Research (ARW) version 4.0.3.
- > The model has been run for 54 hours, including 6 hours of spin-up time, to reach its physical equilibrium state.
- > Lightning option 2: PR92 based on 20 dBZ top, redistribution of the flashes with dBZ > 20 (for convection resolve runs), (Price & Rind, 1992) has been used.

Fig 5 IITM-LLN lightning flash rate on 16 June 2022 over the India region (a) CG (b) IC; Model simulated lightning flash rate on 16 June 2022 using lightning parameterization scheme 2 (c) CG (d) IC; Model simulated lightning flash rate 16 2022 lightning June using on parameterization scheme 11 (e) CG (f) IC

- The IC lightning flashes occur around 1.55 times more frequently than the CG flashes. The peak intensity of lightning occurs at 1100 IST on 17 June, with approximately 18000 flashes.
- The results of model simulation using LP2 are spatial correlates at different regions of the India such as Madhya  $\bullet$ Pradesh, Southern India, and Meghalaya in north eastern region of India.
- The model simulated lighting flash CG (Cloud to Ground) variable has been utilized for the lightning hotspot analysis. The WRF model simulation can accurately predict the location of the lightning hotspot with high intensity.

## Conclusions

- The outcomes clearly demonstrates that the model performed well using LP2 lightning scheme.
- The research concludes that the lightning scheme 2 based on PR92 with top dBZ > 20 with Morrison double moment scheme is suitable for the lightning events prediction.
- The lightning scheme LP2 performed better than the lightning scheme LP11.
- The detection efficiency on June 16, 2022, is around 67.41%, while on June 17, 2022 it is approximately 85.75%. Thus, it clearly evaluates the model performance.
- The Jenks optimization method, sometimes referred to as the Jenks natural breaks classification method, is a technique for data clustering that finds the optimal way to group values into several classes (Jenks, 1963, 1976).
- > The lightning flashes have been compared to the lightning ground observations databases.

**Table 2** WRF model configuration

Parameter	Details	<b>Physics options</b>
WRF version	4.0.3 version	Microphysics
Spatial resolution	20 and 10 Km	Longwave radia
Model integration time	54 Hr	Shortwave radia
Time Step	54 Sec	Land surface ph
Vertical Resolution	34 Level	Surface layer ph
Lightning option	2 and 11	Planetary bound
	(Yair et al., 2010)	Cumulus physic

**Table 3** Physical configuration of
 designed experiments

radiation

radiation

ice physics

yer physics

physics

boundary layer

Schemes

RRTM

RRTMG

MM5

NOAH

GRELL-D

YSU

MORRISON

#### References

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