ABSTRACT ID: 95

COMBINED INFLUENCE OF CAPE AND SPECIFIC HUMIDITY ON LIGHTNING PREDICTION OVER INDIAN REGION

Rinuragavi V N [(1)], Rupraj Biswasharma [(2)], Sunil D Pawar [(2)]

(1) Indian Institute of Science Education and Research (IISER), Pune
(2) Indian Institute of Tropical Meteorology (IITM), Pune

INTRODUCTION:

- Precise determination of atmospheric conditions that initiate is essential to enhance prediction accuracy, particularly in regions like India, where the atmosphere exhibits significant variability.
- Lightning is linked to thermodynamic variables such as Instability, adequate moisture, and Lifting force.
- For many years, meteorologists have relied on thermodynamic indices like CAPE, KI, TTI.
- However, these indices often don't look into the critical role of low-level moisture in the thunderstorm formation.
- Romps et al., (2018) have suggested that the product of CAPE and Precipitation serves as a proxy for lightning prediction for CONUS region.
- However, Our analysis found that correlation between flashcounts and with specific humidity at 850 hPa performs better than precipitation for Indian region.

OBJECTIVES:

1. **Formulate an index for lightning prediction by including low level moisture with the Instability**
2. **Analyse the consistency of the Index over Indian region**

DATA:

IITM LLN currently consists 82 lightning-detecting sensors manufactured by the Earth Networks, USA.

- Low frequency (1 kHz) - Detect CG discharges with 90% detection efficiency
- Middle frequencies (1 kHz to 1 MHz): Used for locating return strokes
- High frequencies (1 MHz to 12 MHz): Detect in-cloud pulses with 50% detection efficiency

When lightning strikes, electromagnetic energy is radiated outwards in all directions. Each sensor records the complete waveform and sends the compressed data packets to the central lightning detection server. Recording whole waveform instead of recording the peak amplitude is useful to differentiate between CG and IC flashes. Mapping of lightning flash is based on Time Of Arrival (TOA) technique. If lightning stokes occur within 700 ms and 10 km of the first stroke that was detected by the sensor, then it is clustered into a flash. Any lightning that contain at least one return stroke is classified as CG flash, otherwise it is considered as IC flash.

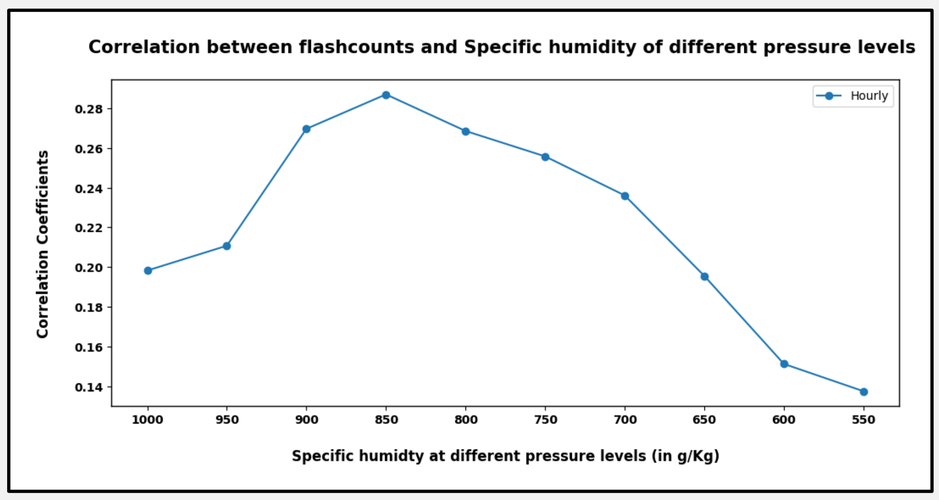
IITM LLN Sensor data (2019-2023) with spatial resolution of 0.25° x 0.25° and hourly temporal resolution was used for the analysis.

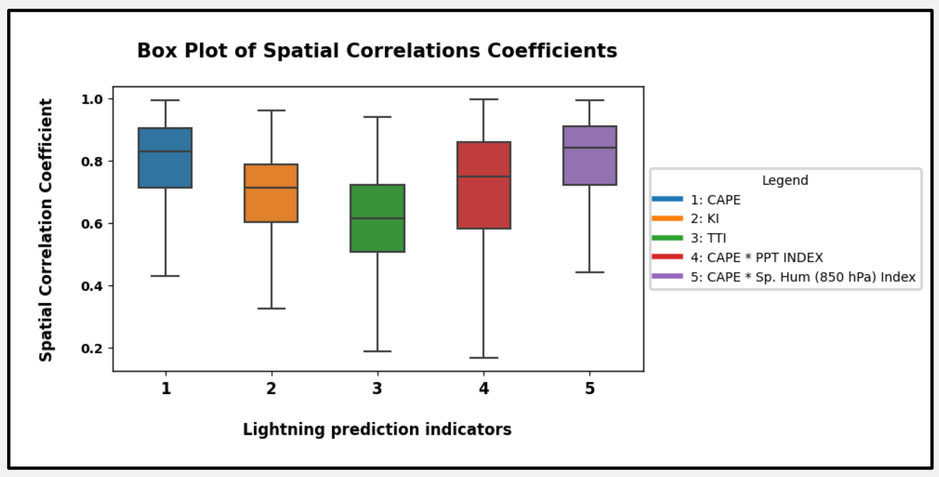
ERA5 is the fifth generation ECMWF reanalysis data

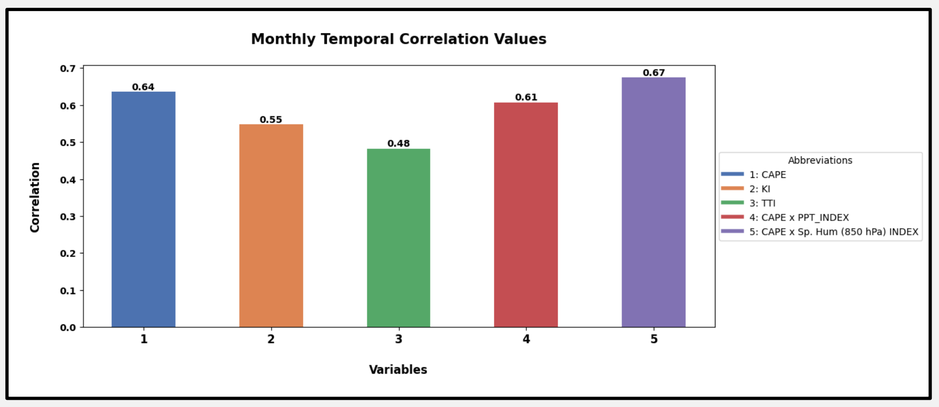
- CAPE Data,
- K Index,
- Totals Total Index,
- Convective Precipitation, and
- Specific Humidity at 850 hPa.

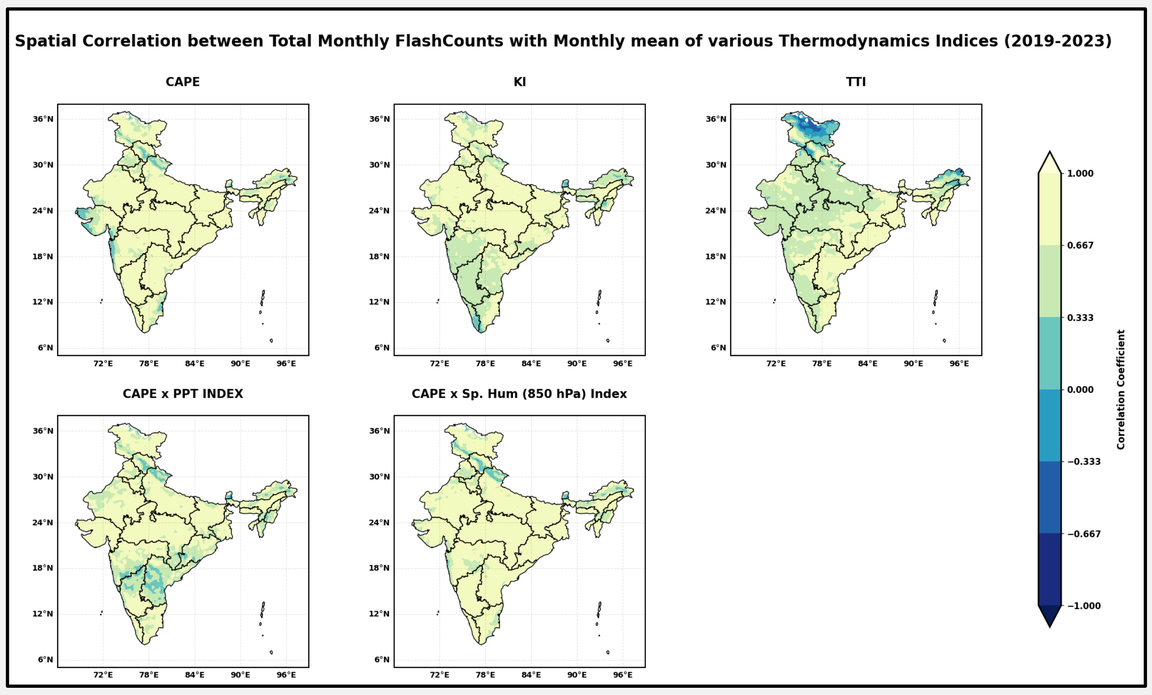
ERA5 data (2019-2023) with Spatial resolution: 0.25° x 0.25°, Temporal resolution: Hourly

RESULTS:

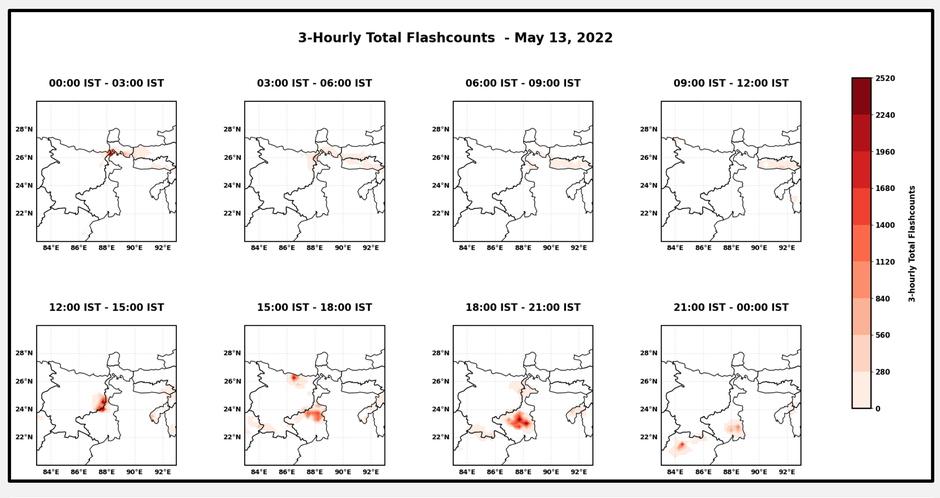


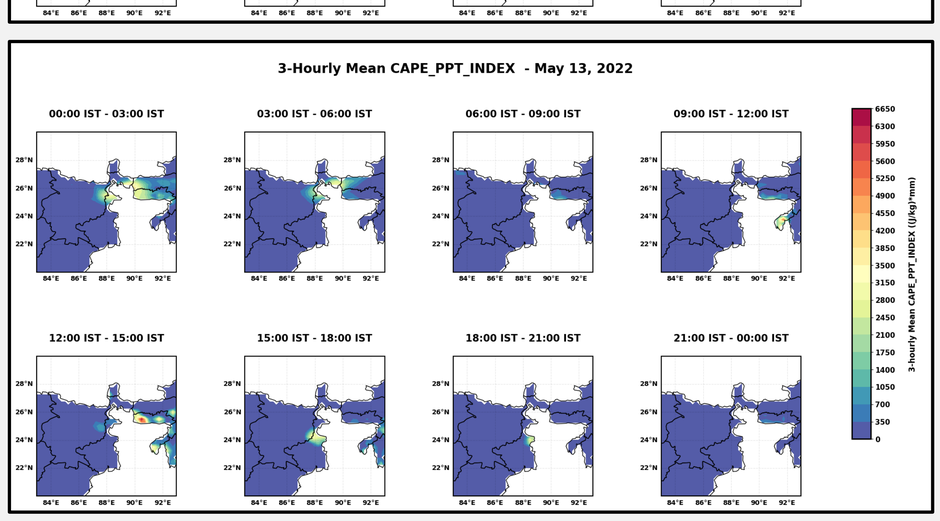


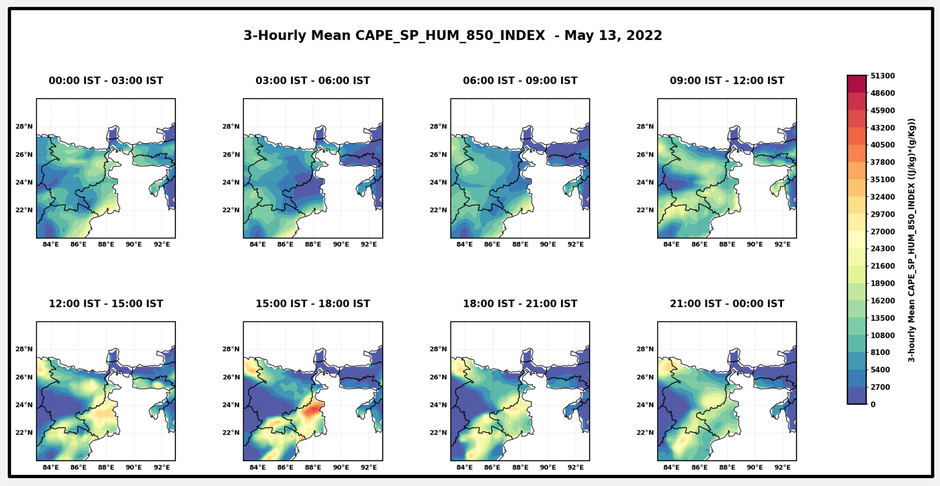




CASE STUDY:







CONCLUSIONS:

- **Specific humidity at 850 hPa was chosen because of its stronger correlation with the observed Flashcounts and better represents the low level moisture among any other pressure levels.**
- **Product of CAPE and Specific humidity at 850 hPa (CSH_{850}) has the highest spatial correlation around 0.84 with the observed Total flashcounts.**
- **CSH_{850} has the highest temporal correlation around 0.67 with the observed Total flashcounts.**
- **Various Case studies have been analysed to validate the performance of CSH_{850} index**
- **Therefore, Product of CAPE and Specific Humidity at 850 hPa (CSH_{850}) exhibiting stronger spatial and temporal correlation can predict lightning activity better than CAPE, KI, TTI and CP.**

References:

1. Murugavel P., Pawar S.D., Gopalakrishnan, V. (2014). Climatology of lightning over Indian region and its relationship with convective available potential energy. International Journal of Climatology, online, 1-9. https://doi.org/10.1002/joc.3901.
2. Romps, D. M., Charn, A. B., Holzworth, R. H., Lawrence, W. E., Molinari, J., & Vollaro, D. (2018). CAPE times P explains lightning over land but not the land-ocean contrast. Geophysical Research Letters, 45(22), 12623–12630. https://doi.org/10.1029/2018gl080267.