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COMBINED INFLUENCE OF CAPE AND SPECIFIC HUMIDITY ON LIGHTNING PREDICTION OVER INDIA

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Abstract:

Precise determination of atmospheric conditions that initiate thunderstorms is essential to enhance prediction accuracy, particularly in regions like India, where the atmosphere exhibits significant variability. Instability, adequate low-level moisture, and lifting mechanisms are fundamental for thunderstorm initiation. For many years, meteorologists have relied on thermodynamic indices like Convective Available Potential Energy (CAPE), K Index (KI), and the Total Totals Index (TTI) to evaluate the likelihood of thunderstorm activity. However, these indices often doesn't overlook into the critical role of low-level moisture in the thunderstorm formation.

In our study, we have analyzed five years of convective parameters from ERA-5 hourly reanalysis data and Indian Lightning Location Network (ILLN) observations over Indian region. Romps et al. (2018) suggested that the product of CAPE and precipitation (hereafter, CP) serves as a proxy for lightning prediction by combining atmospheric instability with moisture, both crucial for convective activity and thunderstorm intensity. However, our analysis found that correlation between flash counts with specific humidity at 850 mb (hereafter, SH_{850}) (low-level moisture) performs better than precipitation, specifically for the Indian region. SH at 850 mb was chosen because it shows a stronger correlation with lightning flash counts (~0.29) compared to other pressure levels between 1000 mb and 550 mb. As a result, SH_{850} was selected over precipitation. The product of CAPE and SH_{850} (hereafter, CSH_{850}) demonstrated a higher spatial and temporal correlation with total lightning flash counts than CAPE, KI, TTI, and CP, making it a more reliable index for predicting lightning and thunderstorms. Both CP and CSH_{850} showed stronger correlations with flash counts when no lead time was applied. Spatially, CSH_{850} and CAPE outperformed KI, TTI, and CP (Figure 1). The temporal correlations for CAPE, KI, TTI, CP, and CSH_{850} were 0.64, 0.55, 0.48, 0.61, and 0.67, respectively. Temporally CSH_{850} outperforms CAPE, KI, TTI and CP. Thus, CSH_{850} exhibiting stronger spatial and temporal correlations can predict lightning activity better than CAPE, KI, TTI, and CP, over India region.

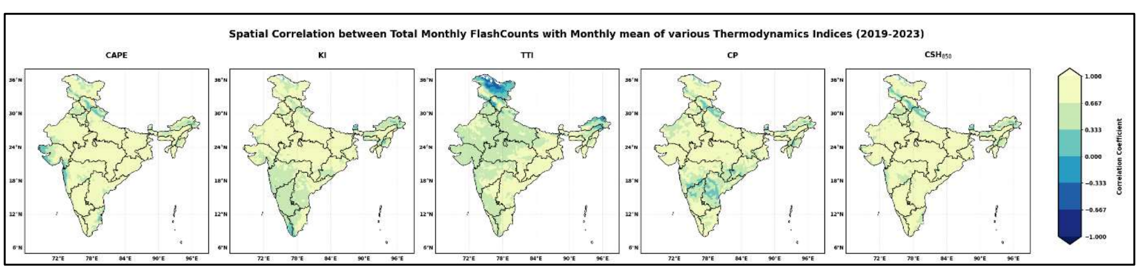

Figure 1. Spatial Correlation between Total monthly Flash counts with Monthly mean of various Thermodynamic Indices. Spatially, CSH850 and CAPE performs better than KI, TTI, and CP.

References:

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