Dust and Smoke from crop residue burning deciphering the aerosols over northwest Region (India)

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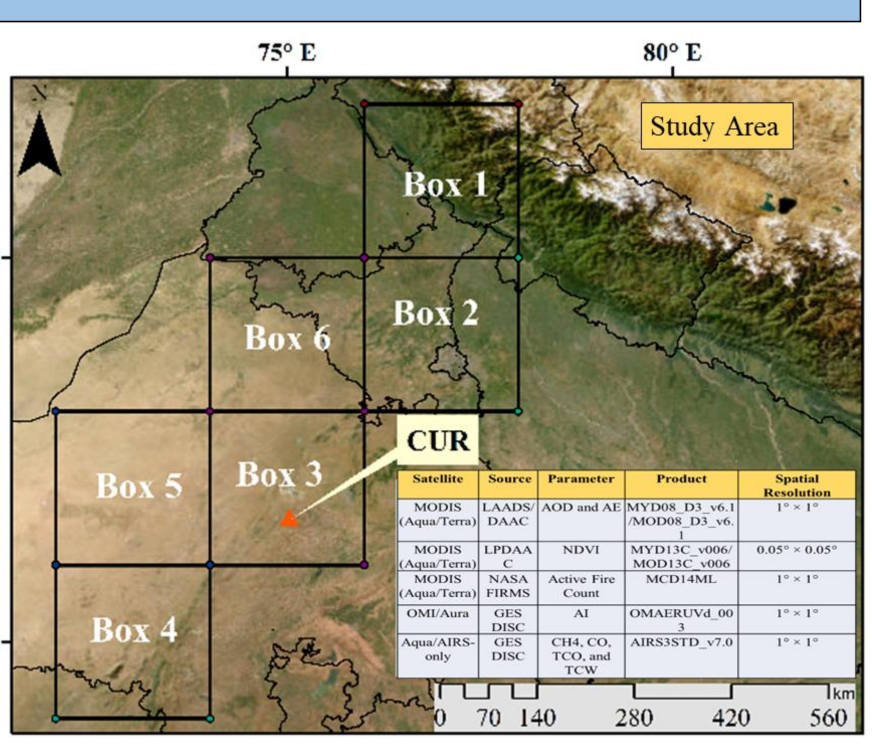
INTRODUCTION

- Biomass burning and dust loading are two major sources of aerosol loading in India.
- In the western part of India, the Thar desert is a major source of dust aerosols whereas biomass burning in the northwestern part of India impacts the whole Indo-Gangetic Plains from October to November each year.
- Biomass burning considerably influence the atmospheric radiative properties at various scales through local emissions and long-range transport mechanism.
- We have analyzed the Spatiotemporal dynamics of aerosol optical properties with the influence of local meteorology. Also studied the trace elements variability to check the influence of crop burning.
- We have also analyzed the multivariate correlation of aerosol optical properties, NDVI, and local meteorology.
- HYSPLIT trajectory analysis shows the sources of the airmass over the Rajasthan region.



Satellite	Source	Parameter	Product	Spatial Resolution
MODIS (Aqua/Terra)	LAADS/ DAAC	AOD and AE	MYD08_D3_v6.1 /MOD08_D3_v6.1	1° × 1°
MODIS (Aqua/Terra)	LPDAAC	NDVI	MYD13C_v006/ MOD13C_v006	0.05° × 0.05°
MODIS (Aqua/Terra)	NASA FIRMS	Active Fire Count	MCD14ML	1° × 1°
OMI/Aura	GES DISC	AI	OMAERUVd_003	1° × 1°
Aqua/AIRS-only	GES DISC	CH4, CO, TCO, and TCW	AIRS3STD_v7.0	1° × 1°

Figure: Study area (northwestern Indian region) representing six boxes used for study and table of data sources. The red triangle (CUR) is the Central university of Rajasthan Campus location.

SPATIOTEMPORAL VARIATIONS OF AEROSOLS (AOD, AE AND AI)

AOD and AE (MODIS-Aqua and Terra)

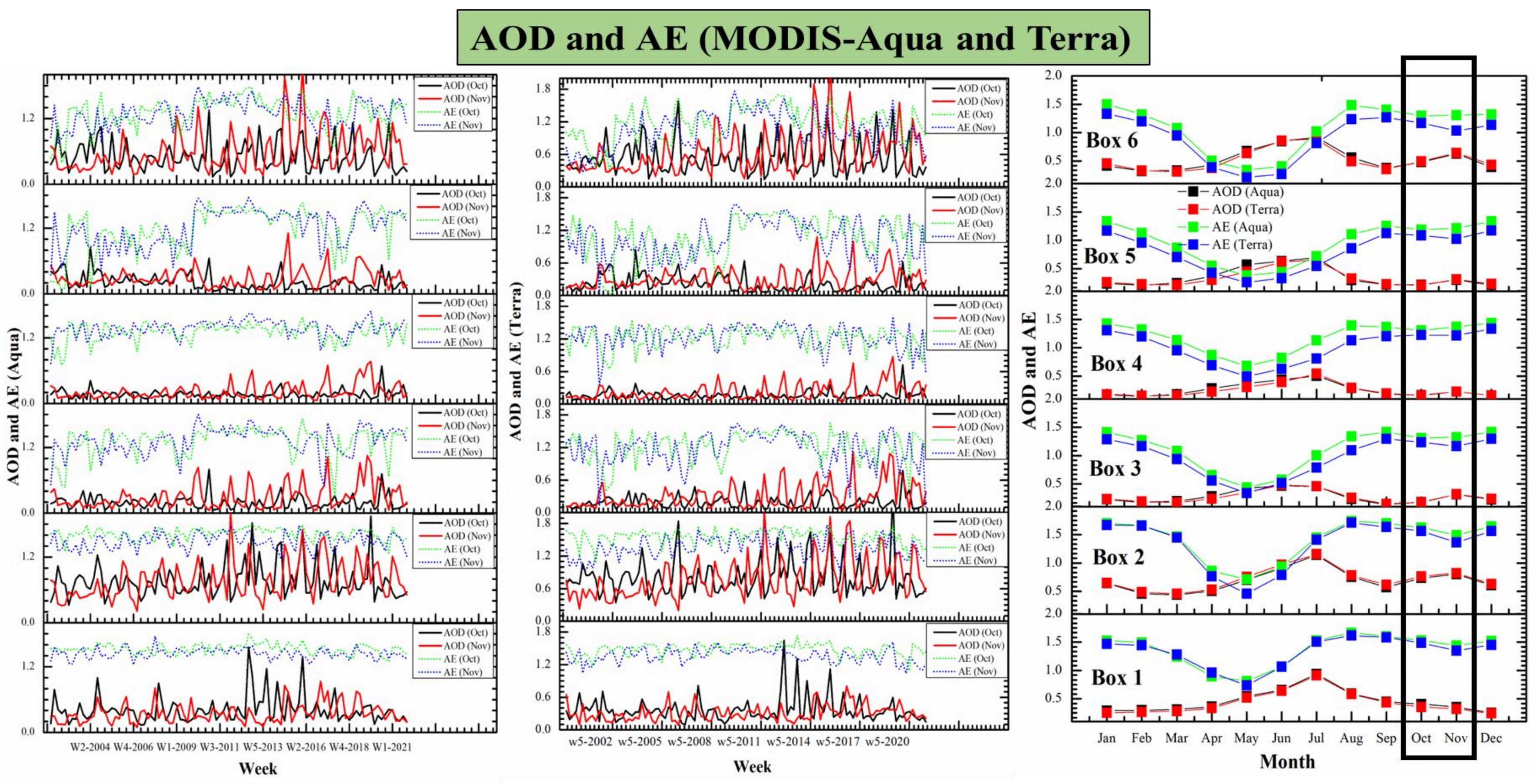


Figure: Weekly and Monthly variations of AOD and AE were computed for period 2003-2022 from MODIS–Aqua/Terra. Monthly variation highlighted by rectangle for crop burning period (Oct-Nov). AOD and AE showed similar pattern of trend. The mean weekly average of AOD was >0.5 while AE >1. which represented higher loading of aerosols over northwest India.

Aerosol Index (AI)

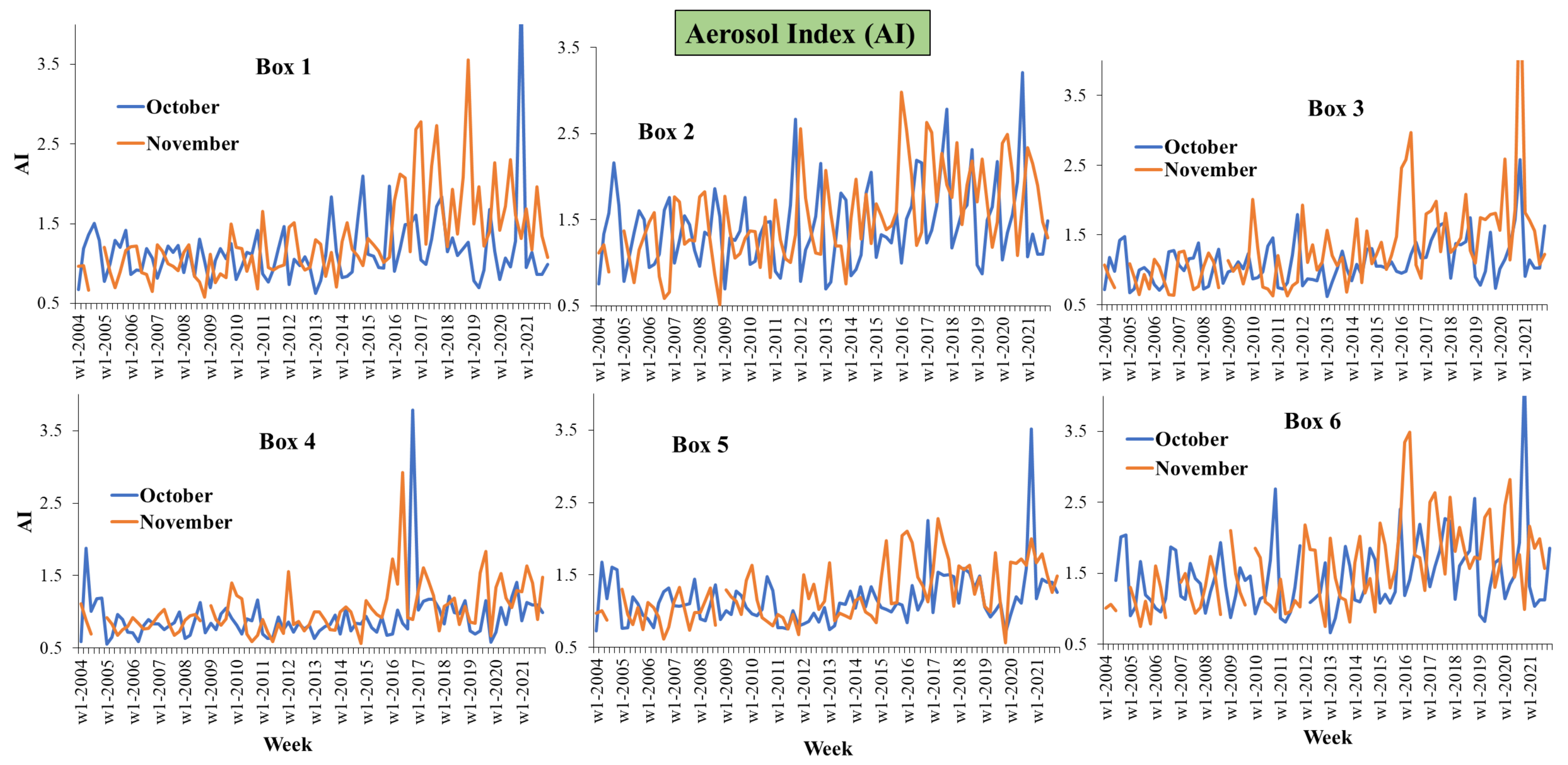


Figure: Weekly variations of aerosol index (AI) for period 2004-2022 (OMI-UVAI dataset). Weekly average AI value over the years has increased. The average weekly mean of AI is 1.2 which represent presence of the dust aerosols.

SPATIOTEMPORAL VARIATIONS OF NDVI

Normalized Differential vegetation Index

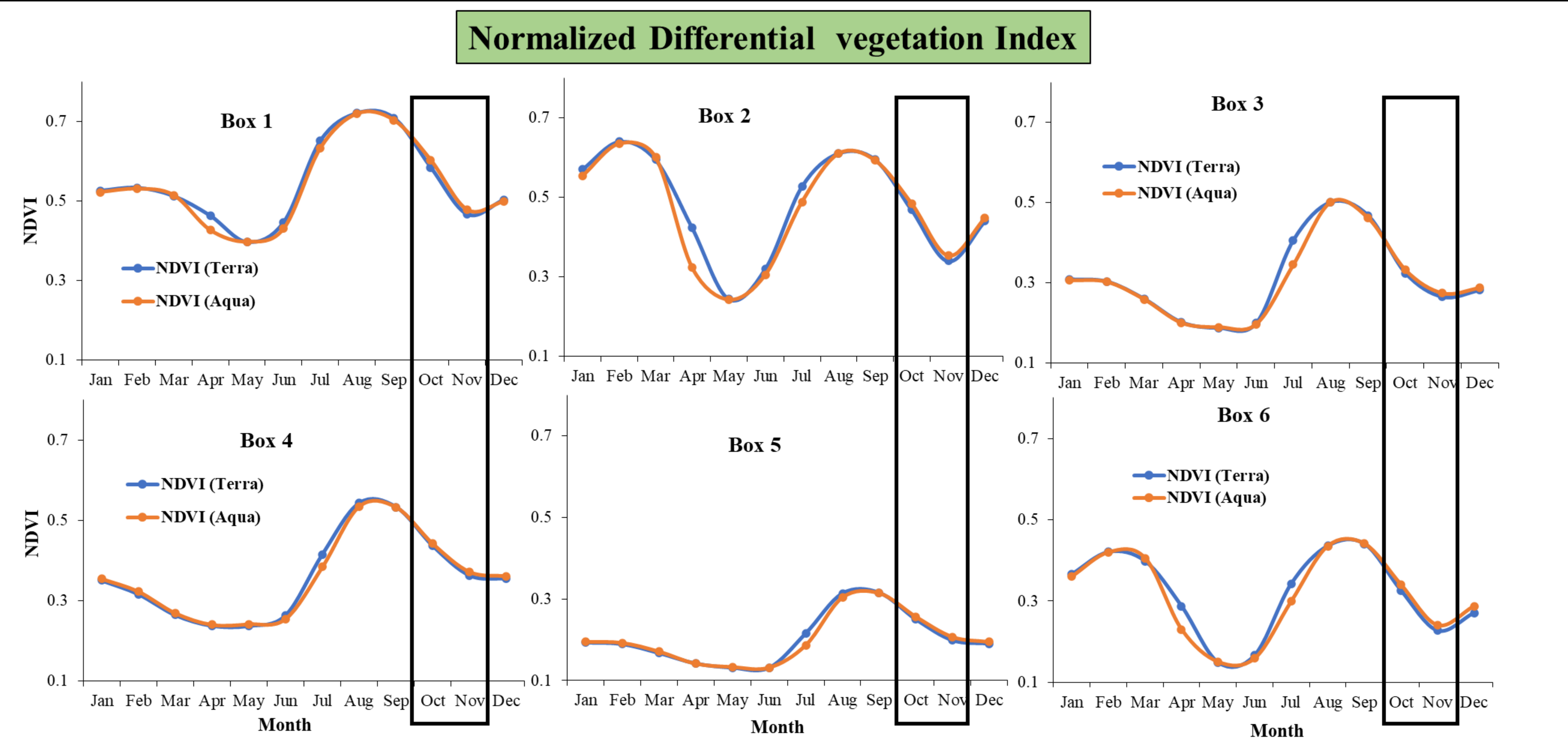


Figure: Monthly variations of NDVI for period 2003-2022 from MODIS–Aqua/Terra at northwest India. NDVI represented the bimodal trend for monthly variations due to crop (Rabi and Kharif crops) sowing and harvesting period in each year. NDVI showed an increasing trend in recent years.

SPATIOTEMPORAL VARIATIONS OF FIRE COUNTS

Fire counts

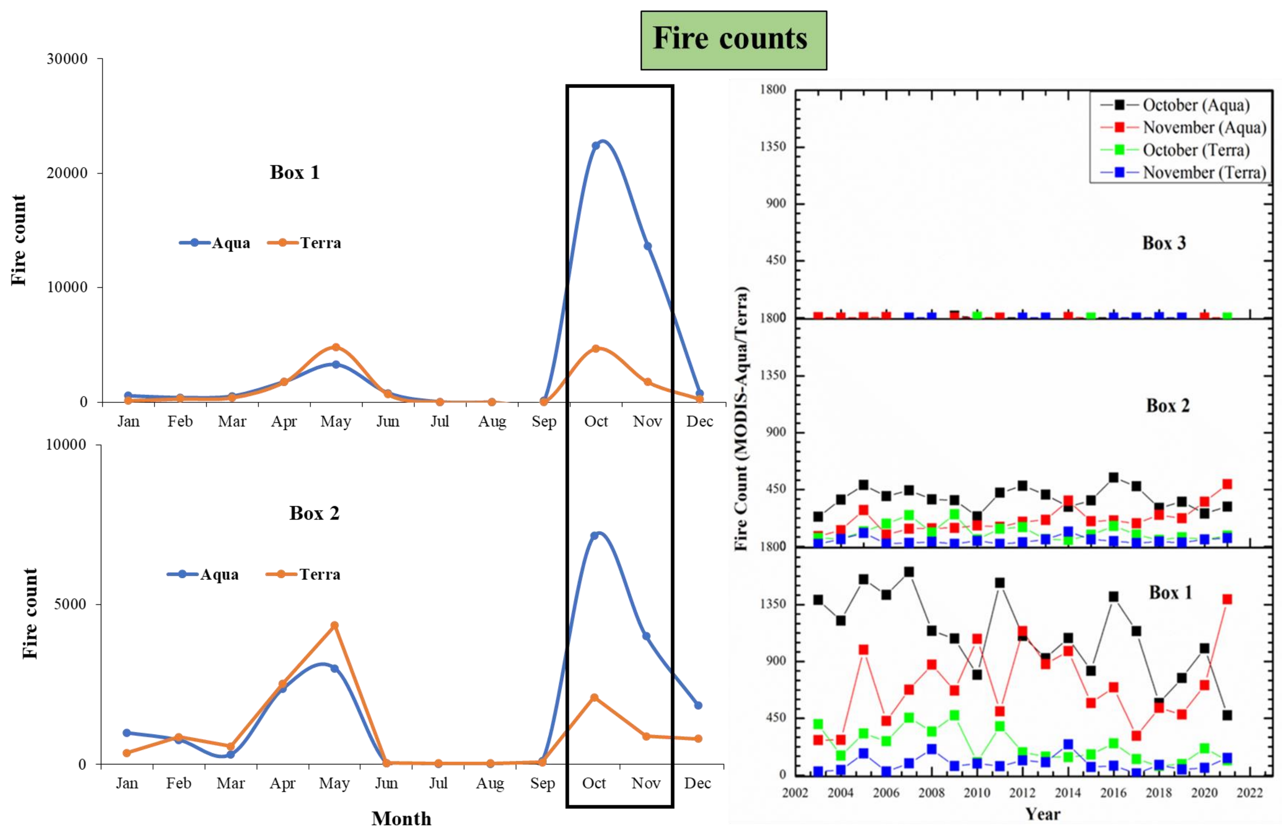


Figure: Monthly (left) and interannual (right) variations of fire counts for period 2003-2022 from MODIS–Aqua/Terra for crop residue burning period (Oct-Nov of each year). The black rectangle represented the crop burning period at box 1 and 2. bimodal monthly variation were observed with maximum fire counts were observed in Oct-Nov months of each year at box 1 and 2. Interannual variations of fire counts were showed zigzag trend due to uncertainities in exact crop harvesting time each year at box 1, 2, and 3. >80% confidence were included for fire counts, therefore no or very limited fire were observed at other boxes.

VARIABILITY OF TRACE ELEMETS (CH_4, CO, TCO, AND TCW)

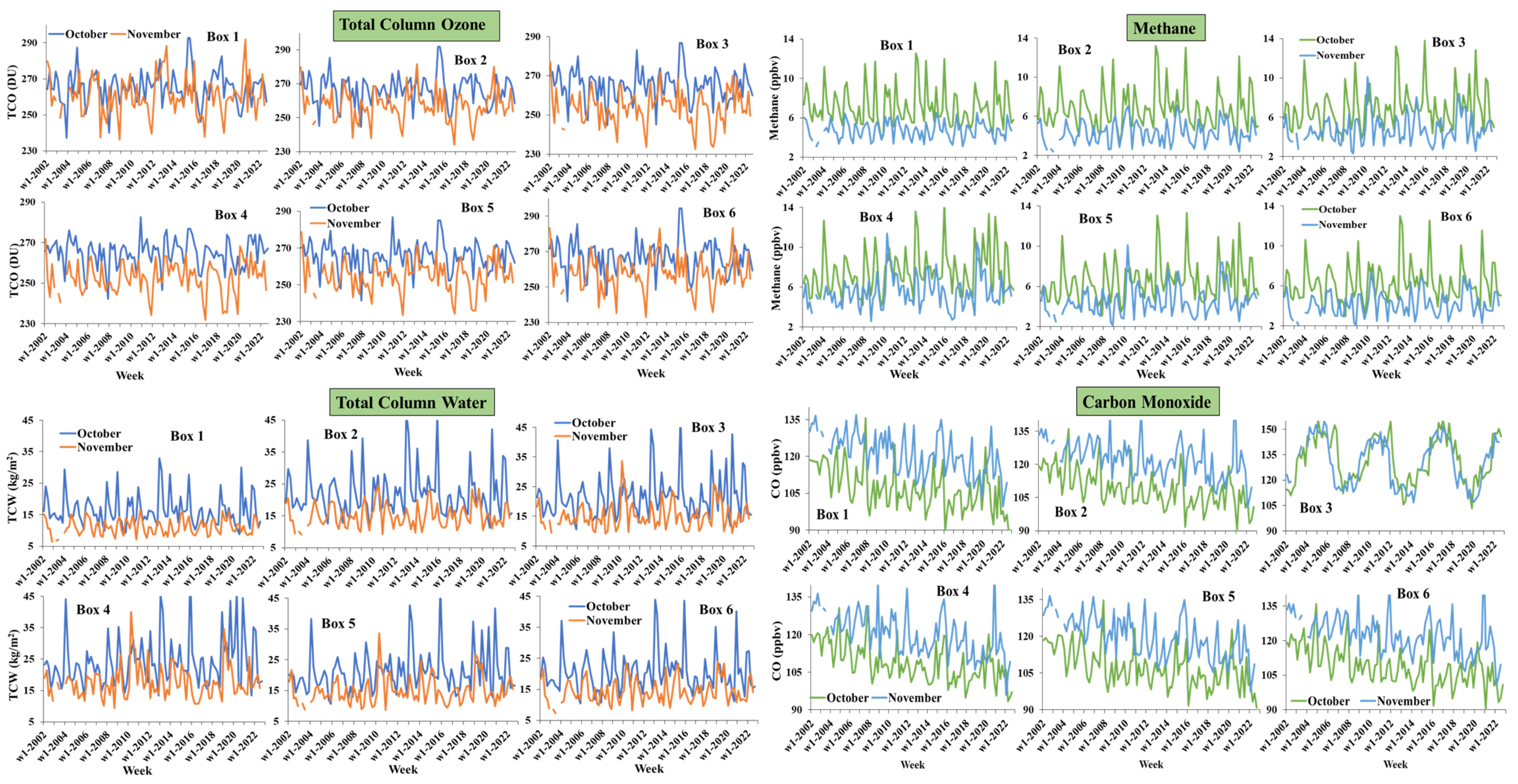


Figure: Weekly variations of CH_4, CO, TCO, and TCW for crop burning period (October and November) over 2003-2022. weekly variation are very dynamic for crop residue burning period over past two decades.

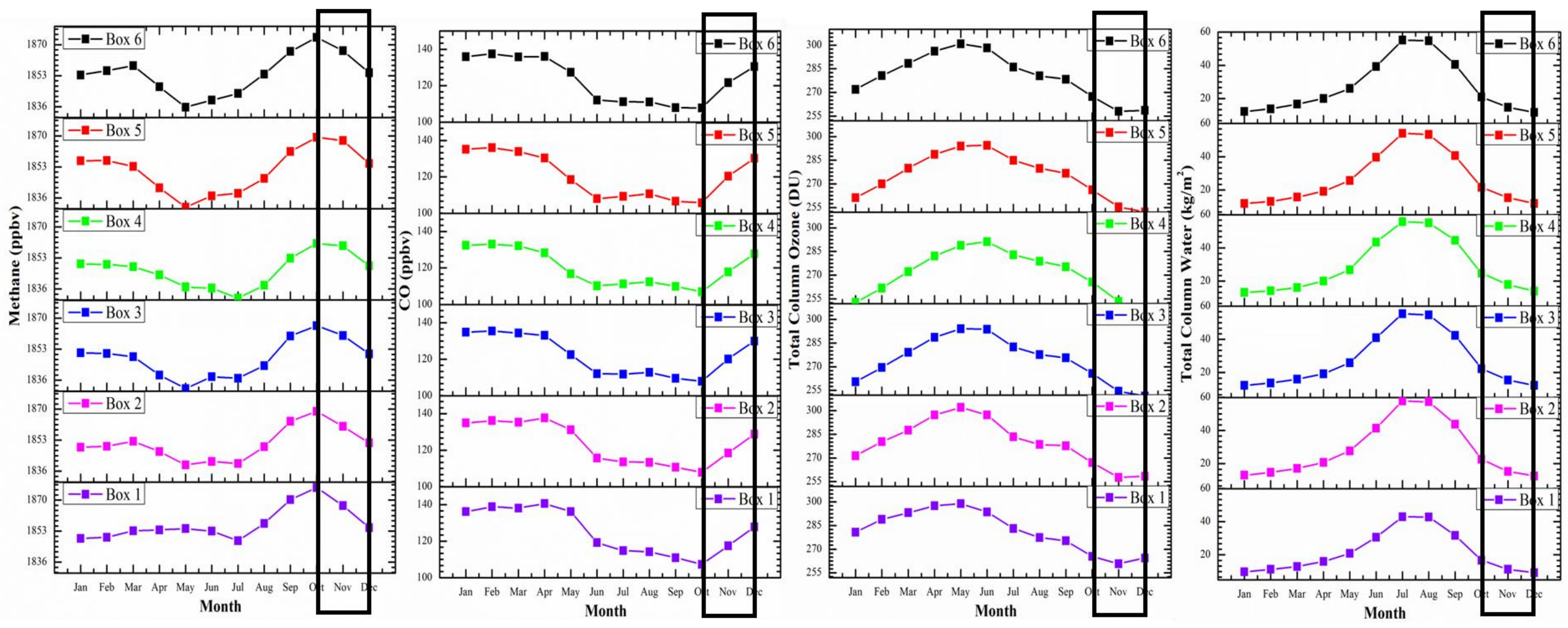
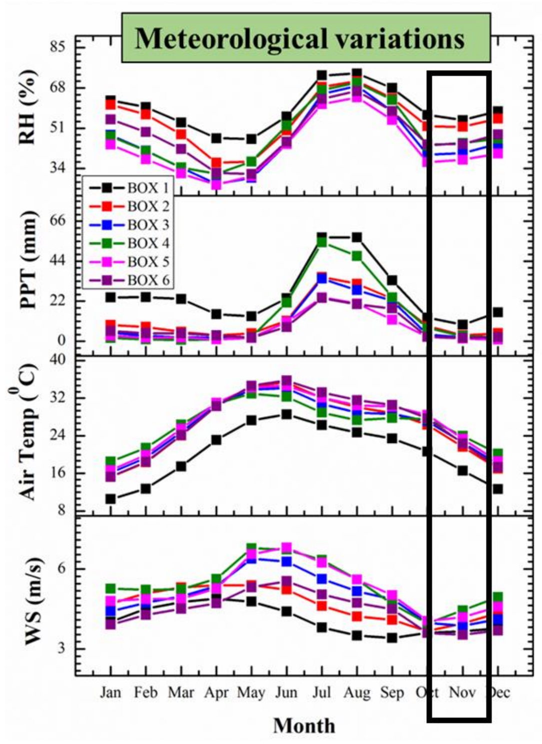


Figure: Monthly variations of CH_4, CO, TCO, and TCW for period 2003-2022. CH_4 and TCW showed decreasing trend while CO increasing trend in Oct and Nov at all boxes. TCO presented increasing trend over boxes 3, 4, and5 while increasing at boxes 1, 2, and 6, as these boxes lies over Punjab and Haryana which are major source of crop residue burning and other anthropogenic activities.

CORRELATION WITH METEOROLOGY

Meteorological variations



Correlation Matrix

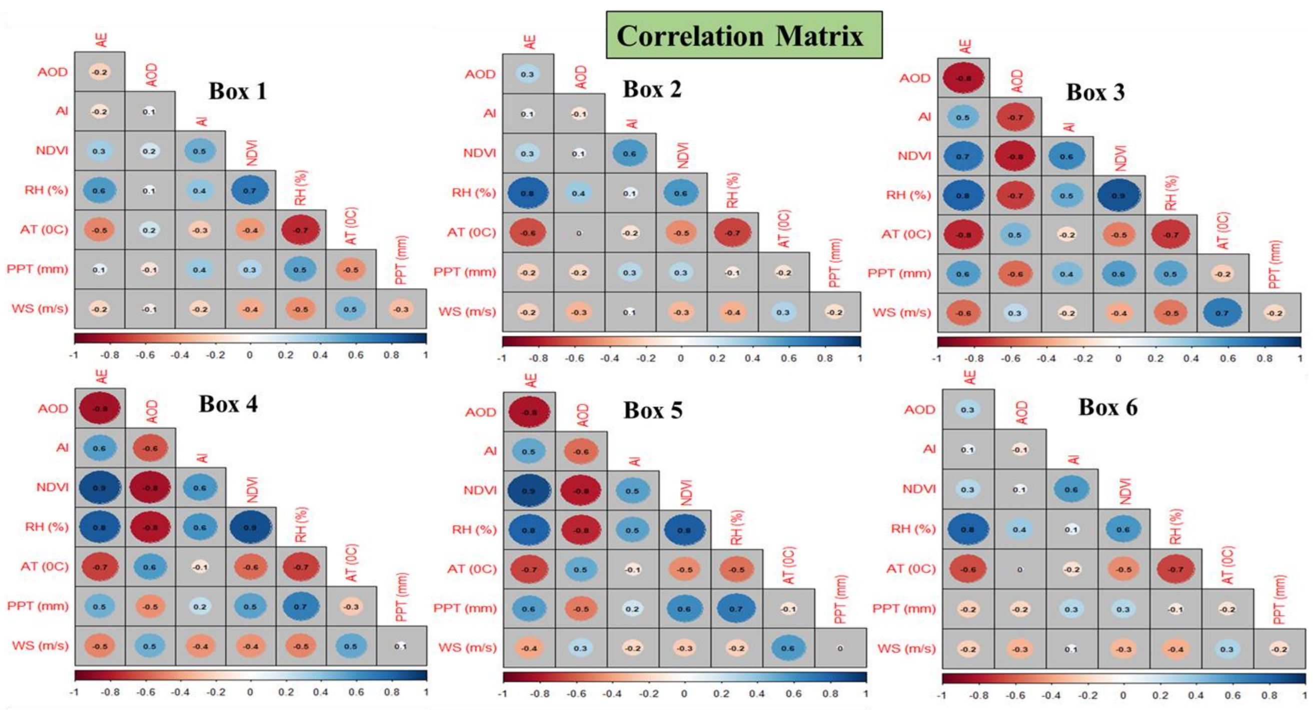


Figure: Monthly variations of meteorological parameters for past two decades (2003-2022). Local meteorology showed normal pattern for all locations over time.

Figure: The correlation matrix were prepared for six location to understand the relationship between aerosol optical properties (AOD,AE, and AI), vegetation (NDVI) and meteorology (relative humidity (RH), precipitation (PPT), air temperature (Air Temp) and wind speed (WS).

AIRMASS TRAJECTORY

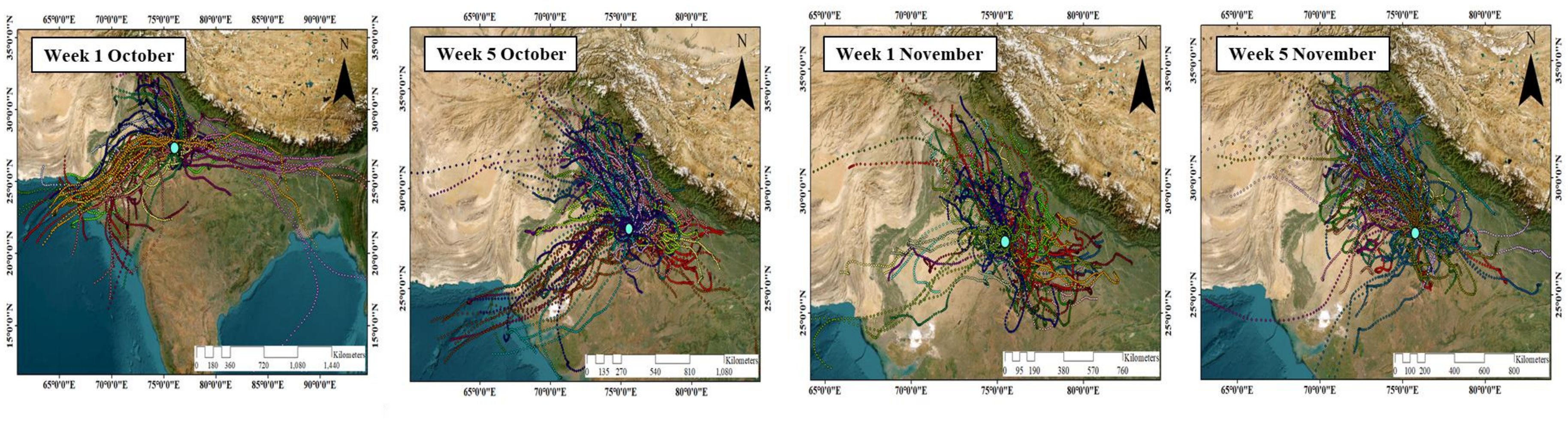


Figure: This represents 100 hours run of backward HYSPILT trajectories coming from the Thar desert, Arabia peninsula and regional anthropogenic sources (Punjab and Haryana) over Rajasthan during Oct-Nov over two decades (2003-2022). The long-range transport of dust from the Arabia peninsula and smoke from Punjab crop burning affect the aerosol properties over Rajasthan during Oct. and Nov.

HIGHLIGHTS

- Spatiotemporal dynamics resulted that October and November months of each year show higher concentrations of AOD and AE that revealed dominant air pollutants with poor air quality as compared to all other months of the year (Except March-April in few years).
- Multivariate correlation analysis shows that at box 1, 2, and 6 locations, most of the parameters were less correlated with meteorology, while over 3, 4, and 5, all parameters were highly correlated with each other. Also these locations have opposite relation of aerosol optical depth with meteorology.
- HYSPLIT backward trajectories show that emission sources of pollutants during Oct and Nov months were from the northern part of India toward Rajasthan due to the crop residue burning.
- In between two months, the Diwali festival is also celebrated in India each year; this might be the reason for the elevated AOD and AE in the northwest India.

ACKNOWLEDGEMENT

Our thanks to

- NASA Giovanni team for providing MODIS and AIRS data.
- NOAA ARL for the HYSPLIT trajectory model.
- The Central University of Rajasthan for giving us access to GIS-Remote Sensing Laboratory for the present.

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