Carbonaceous aerosols from open burning and its impact on regional weather in South Asia

Prashant Singh*, Pradip Sarawade, Bhupesh Adhikary*

*International Centre for Integrated Mountain Development, Kathmandu, Nepal and Department of Physics, University of Mumbai, Mumbai, 400098, India.

Presented by **Prashant Singh**

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Highlights

- Study of carbonaceous aerosol (CA) emissions from open biomass burning over South Asia
- Vertical and horizontal distribution of CAs from open biomass burning
- Impact of CAs on radiative forcing and meteorological parameters quantified

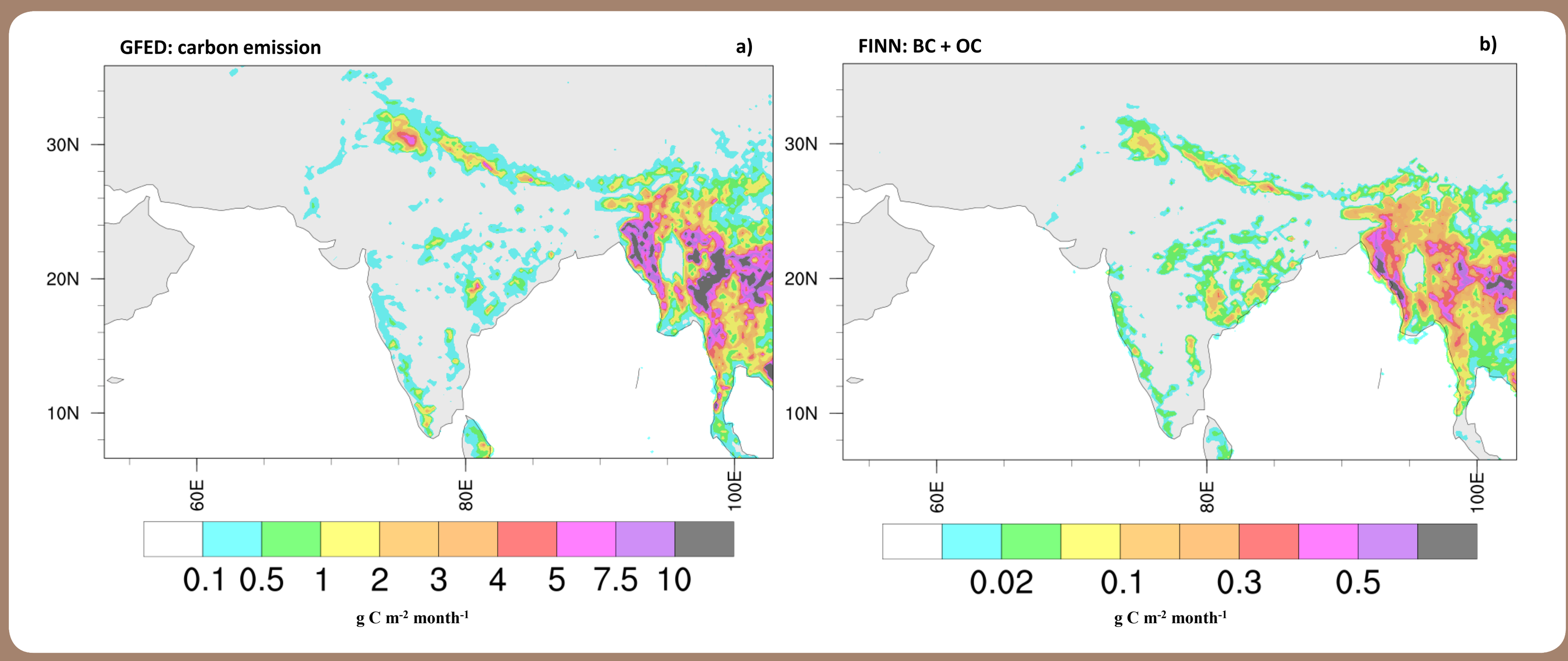

Fig. 1: **Long-term average of carbon emission from fire: (a) GFED monthly average from 1997–2015 total carbon emission, (b) FINN (black + organic carbon) CA emission rate average from 2002–2015**

Background

- Carbonaceous aerosols (CAs) – generally denoted as black carbon (BC) and organic carbon (OC) – together play an important role in the weather and climate system of the atmosphere.
- Major components of CA come from anthropogenic activities/sources during specific months. A significant amount of CAs in the atmosphere originate from open biomass burning.
- CAs from open biomass burning are co-emitted along with both long- and short- lived climate forcers such as carbon dioxide (CO_2), carbon monoxide (CO), and sulphur dioxide (SO_2).

Climatology

- GFED monthly biomass burning carbon emission from 1997 to 2015 was used to identify the hotspots for fires in south Asia (6.5°–36.0°N, 53.0°–103.0°E).
- FINN dataset from 2002 to 2015 was used to locate the hotspots for fires in south Asia and average emission of CA from fires.
- From Fig. 2, Punjab (28.83°–32.01°N, 72.91°–77.86°E) and Myanmar (13.86°-27.74°N, 90.28°-102.69°E) were identified as hotspots for biomass burning.

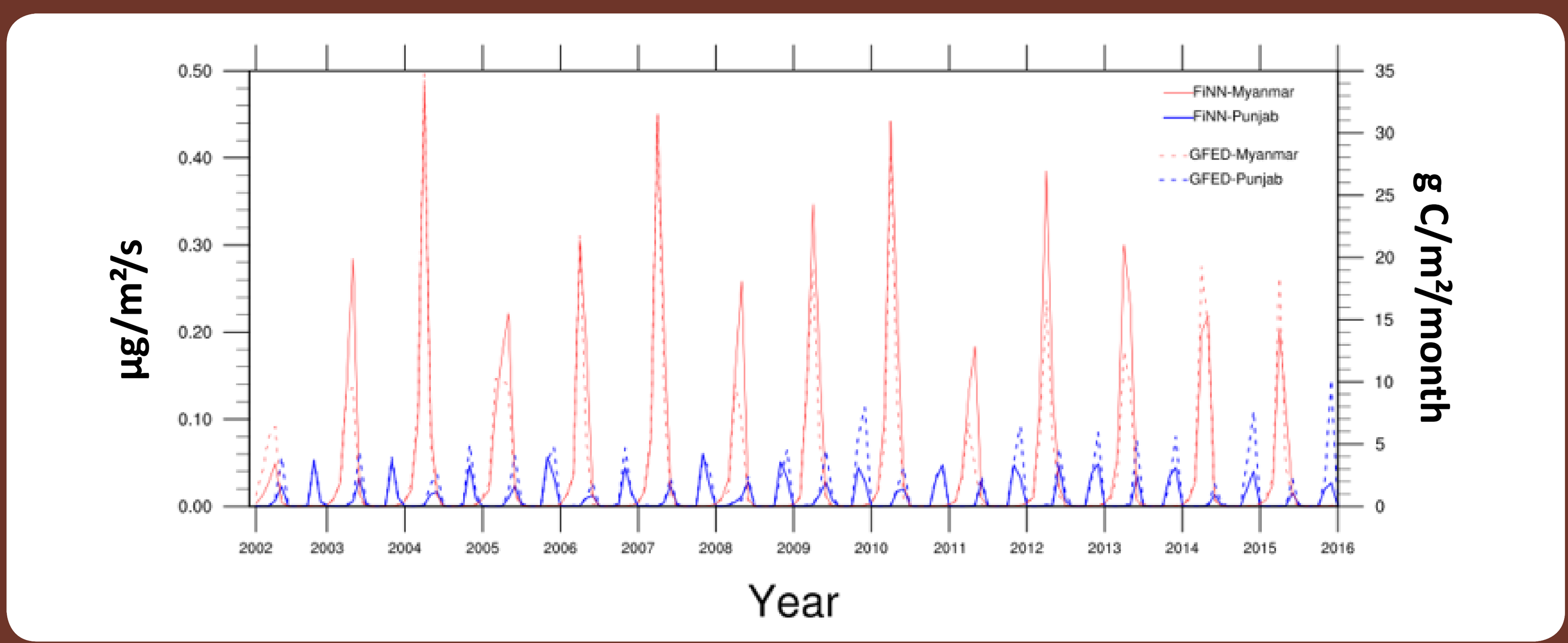

Fig. 2: **Area average emission from GFED (total carbon emission) and FINN (black + organic carbon).**

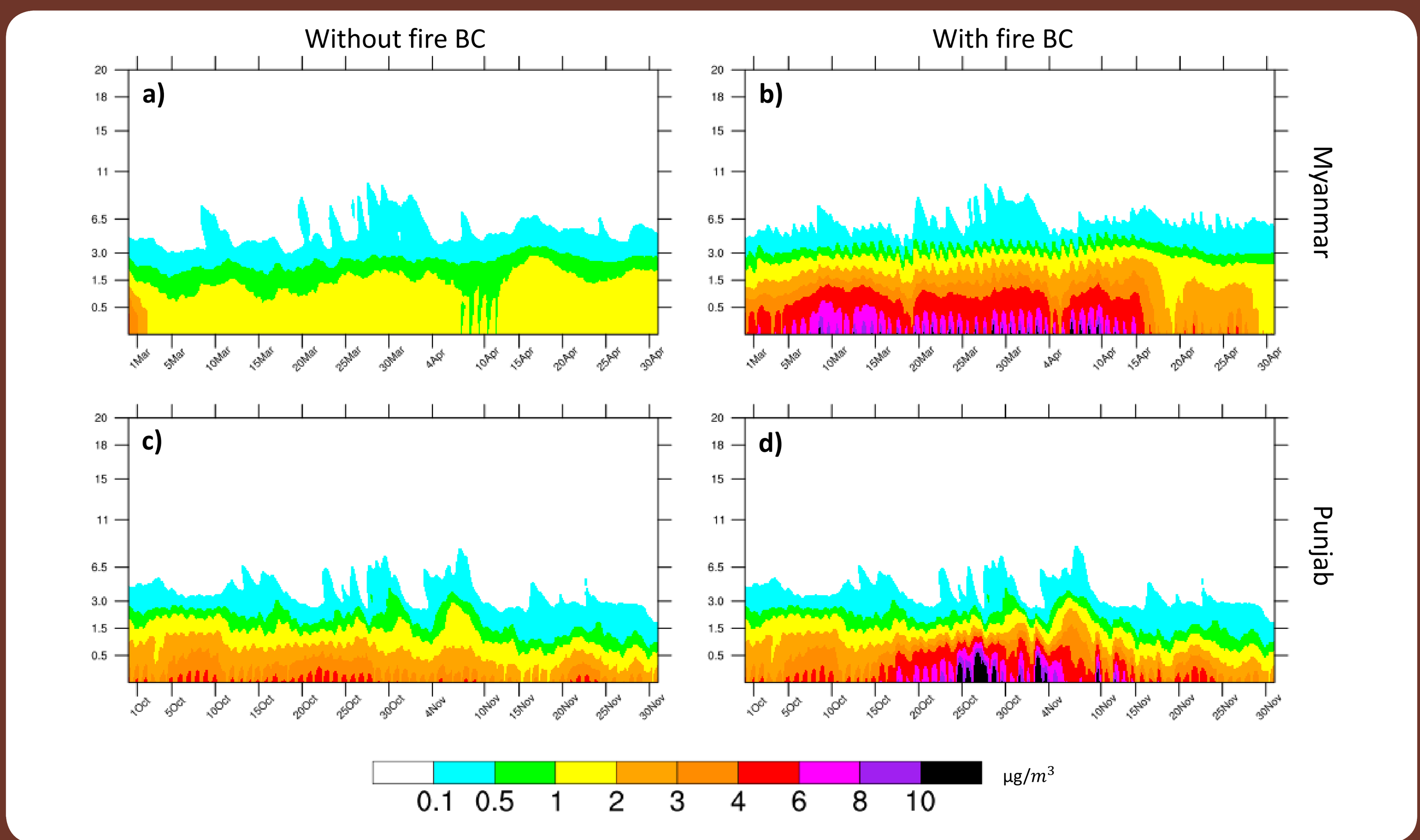

Fig. 3: **Area average BC concentration over Myanmar (a) without and (b) with fire BC; over Punjab (c) without and (d) with fire BC.**

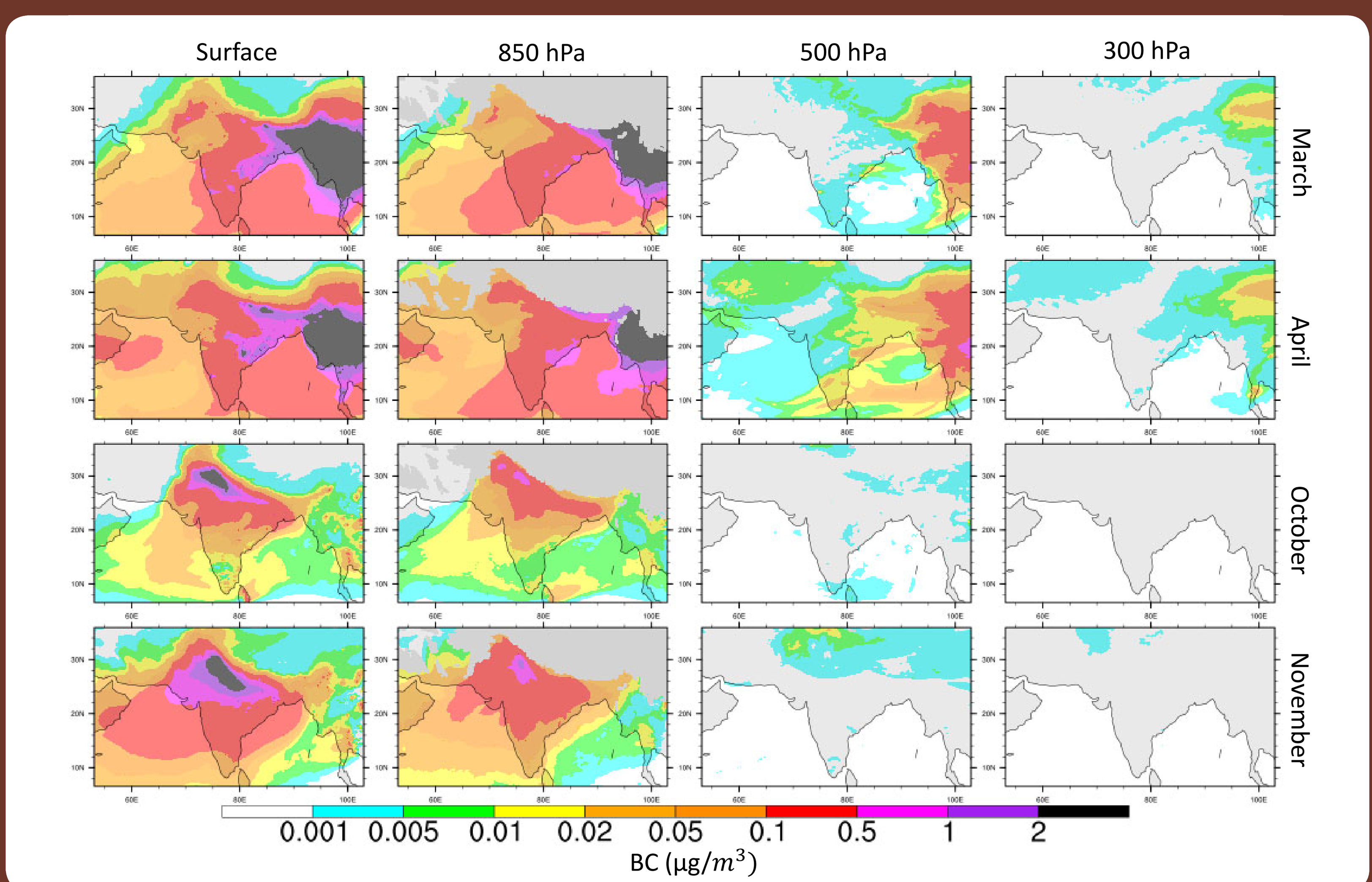

Fig. 4: **Atmospheric loading of BC from fire at (a) surface, (b) 850 hPa, (c) 500 hPa, and (d) 300 hPa.**

Case studies

Model setup

- WRF-Chem (version 3.8.1) is used in this study on Mercator projection centered at 22°N, 78°E, which covers from 6.5°–36.0°N and 53.0°–103.0°E on a spatial resolution of 25 km.
- Two sets of model simulation using MOZCART chemistry were performed with and without biomass burning.

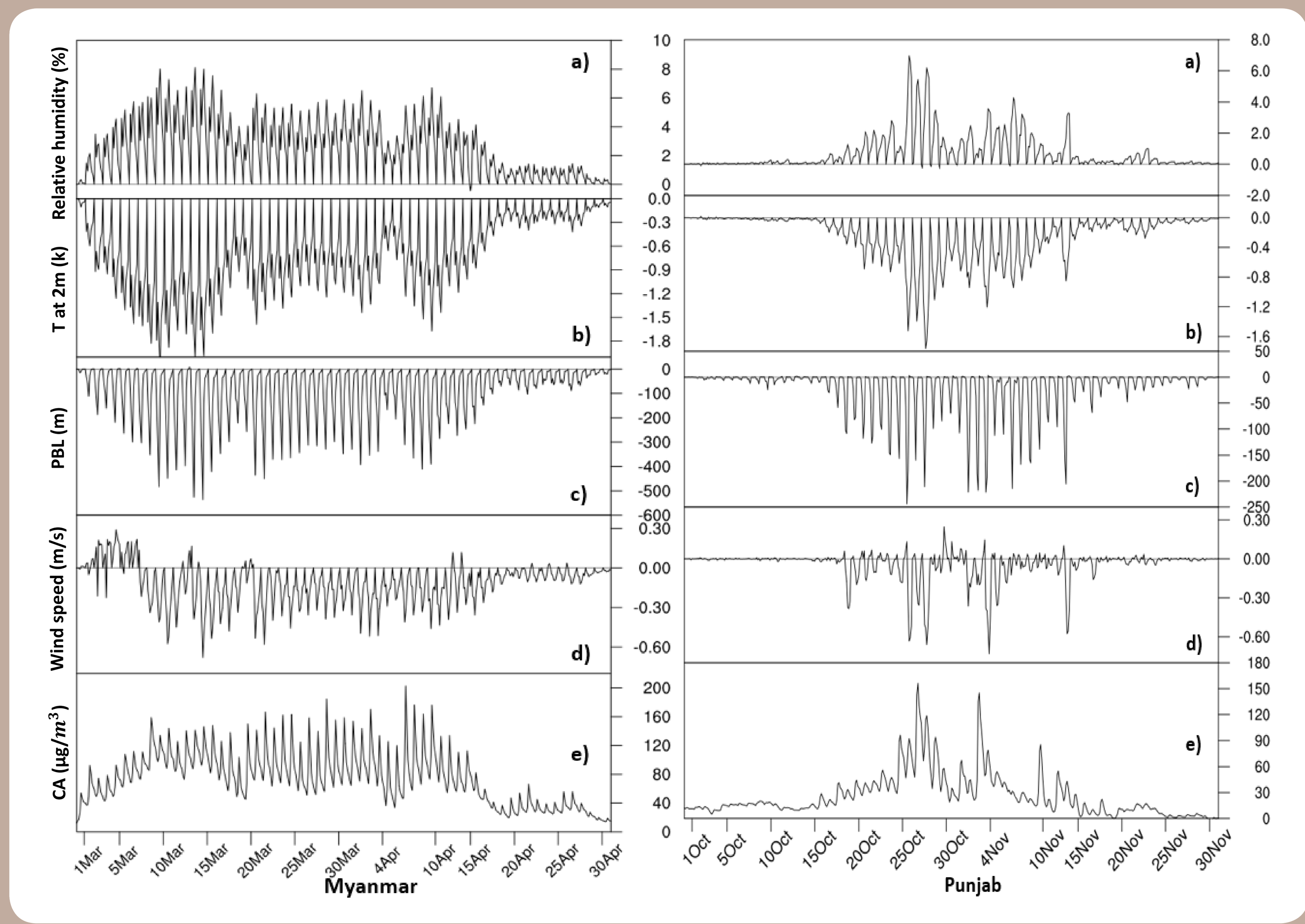

Fig. 5. **Effect of fire-added CA on (a) relative humidity 2 m, (b) temperature 2 m, (c) PBL, (d) wind speed 10 m, and (e) area average CA concentration for Myanmar and Punjab, respectively.**

Table1: **Effect of Myanmar and Punjab on immediate incoming and outgoing radiation budgets over the respective area of fire.**

Region	Month	Domain area average effect			Local area average effect		
		CA added from fire (μg/m³)	Surface incoming short wave flux (W/m²)	TOA outgoing longwave wave flux (W/m²)	CA added from fire (μg/m³)	Surface incoming short wave flux (W/m²)	TOA outgoing longwave wave flux (W/m²)
Myanmar (13.86°-27.74°N, 90.28°-102.69°E)	March	11.47	-8.05	-0.28	78.61	-42.76	-1.91
	April	7.87	-6.78	-0.1	51.26	-29.16	-0.52
Punjab (28.83°-32.04°N, 72.91°-77.86°E)	October	0.70	-0.45	-0.02	18.27	-5.13	-0.48
	November	1.90	-1.34	-0.06	16.73	-6.14	-0.50

Conclusion

- GFED4 and FINN fire products (Fig. 1 and Fig. 2) represent Punjab (April and May/October and November) and Myanmar (March and April) as major contributors of emissions from biomass burning, along with some small emission sources from South Asia.
- Area average time-series vertical profile of CAs shows that during March and April a significant amount of CAs are transported to the free troposphere from PBL (Fig. 3), whereas the October–November profile shows that CAs are unable to cross PBL.
- Fig. 4 shows that uplifted CA from Myanmar fire is able to reach the layer above 500 hPa during March–April, which may affect the moisture uptake during pre-monsoon and result in less precipitation during this period. Radiative feedback is strongly visible because of the presence of fire-emitted CAs.
- Fig. 5 shows the direct effect of fire-emitted CAs, which reduces the wind speed, PBL height, and temperature at 2 m with increase in humidity at 2 m. Such a drastic change in meteorology feedback is responsible for bad air quality in the region. During October–November, PBL is already low and fire-emitted CAs further decrease it, which traps CA. Reduced wind speed and increased humidity make a positive feedback on CA concentration.

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