

Evolution of high pollution events in Delhi NCR, Haryana and Punjab during the monsoon to post-monsoon transition

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大学共同利用機関法人
人間文化研究機構 総合地球環境学研究所



Chiba University



AAKASH PROJECT (4/2020-03/2025)

AN INTERDISCIPLINARY STUDY TOWARD
CLEAN AIR, PUBLIC HEALTH, AND SUSTAINABLE AGRICULTURE:
CASE OF CROP RESIDUE BURNING IN NORTH INDIA

Project Leaders:

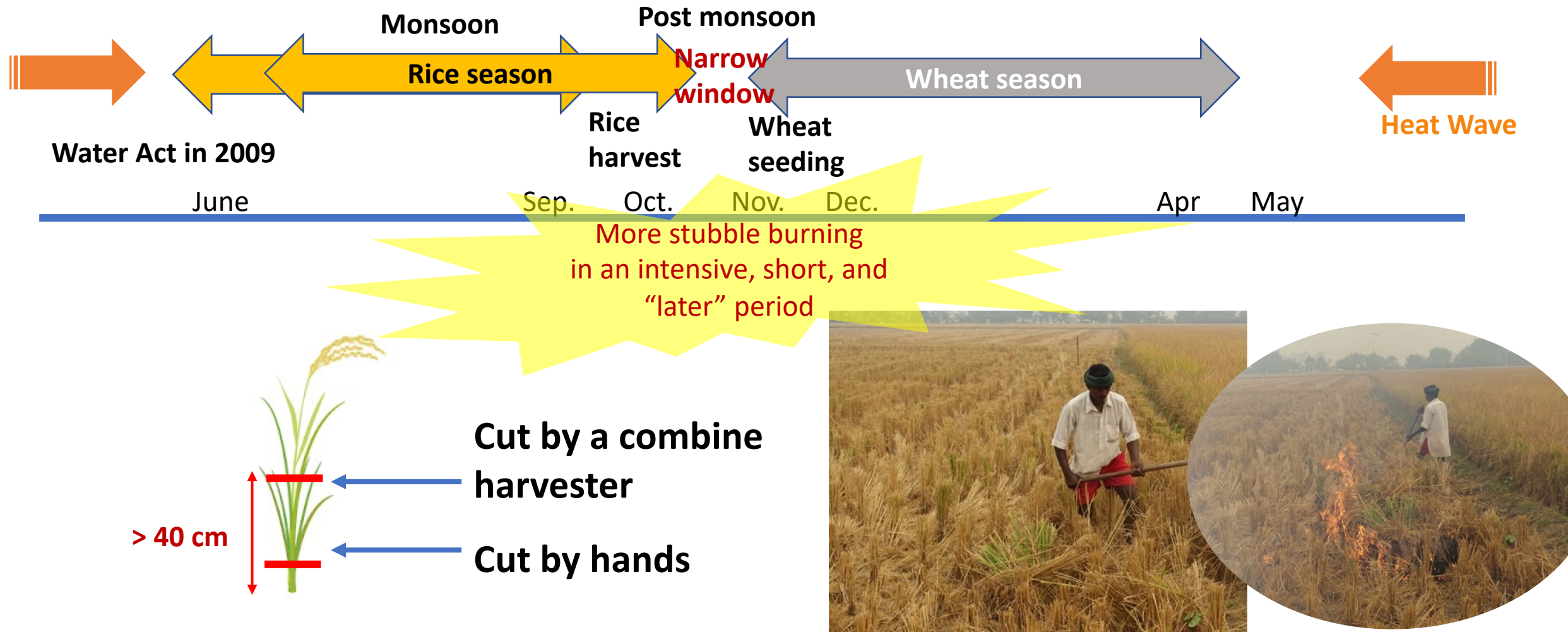
Sachiko HAYASHIDA (2020-2023), Prabir PATRA (2023-2025)

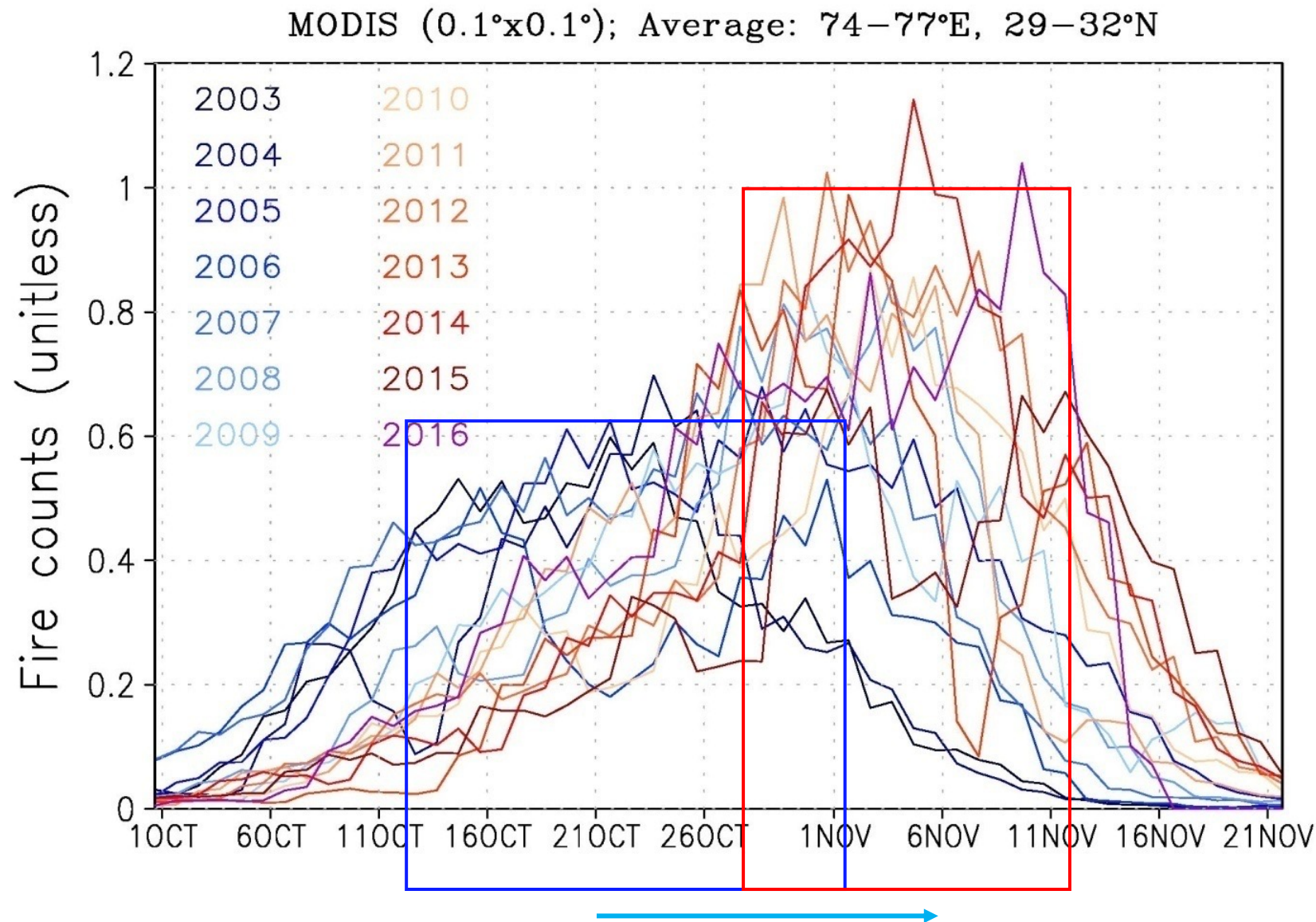
My presentation is based on an analysis by:

Tanbir Singh, Yutaka Matsumi, Tomoki Nakayama, Sachiko Hayashida, Prabir K. Patra, Natsuko Yasutomi, Mizuo Kajino,
Kazuyo Yamaji, Pradeep Khatri, Masayuki Takigawa, Hikaru Araki, Yuki Kurogi, Makoto Kuji, Kanako Muramatsu,
Ryoichi Imasu, Anamika Ananda, Ardhi A. Arbain, Ravindra Khaiwa, Sanjeev Bhardwaj, Sahil Kumar, Sahil Mor,
Surendra K. Dhaka, A. P. Dimri, Aka Sharma, Narendra Singh, Manpreet S. Bhatti, Rekha Yadav, Kamal Vatta, Suman Mor

Why do farmers burn rice straw?

By
Sachiko Hayashida



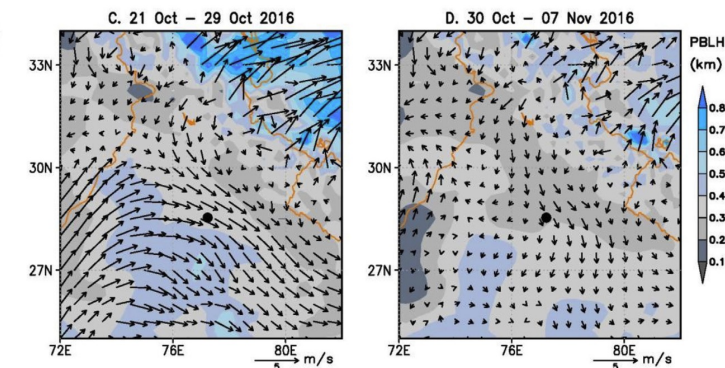


Sawhani et al., Atmos. Pollution Res., 2018

Monsoon transition:
one week of delay matters

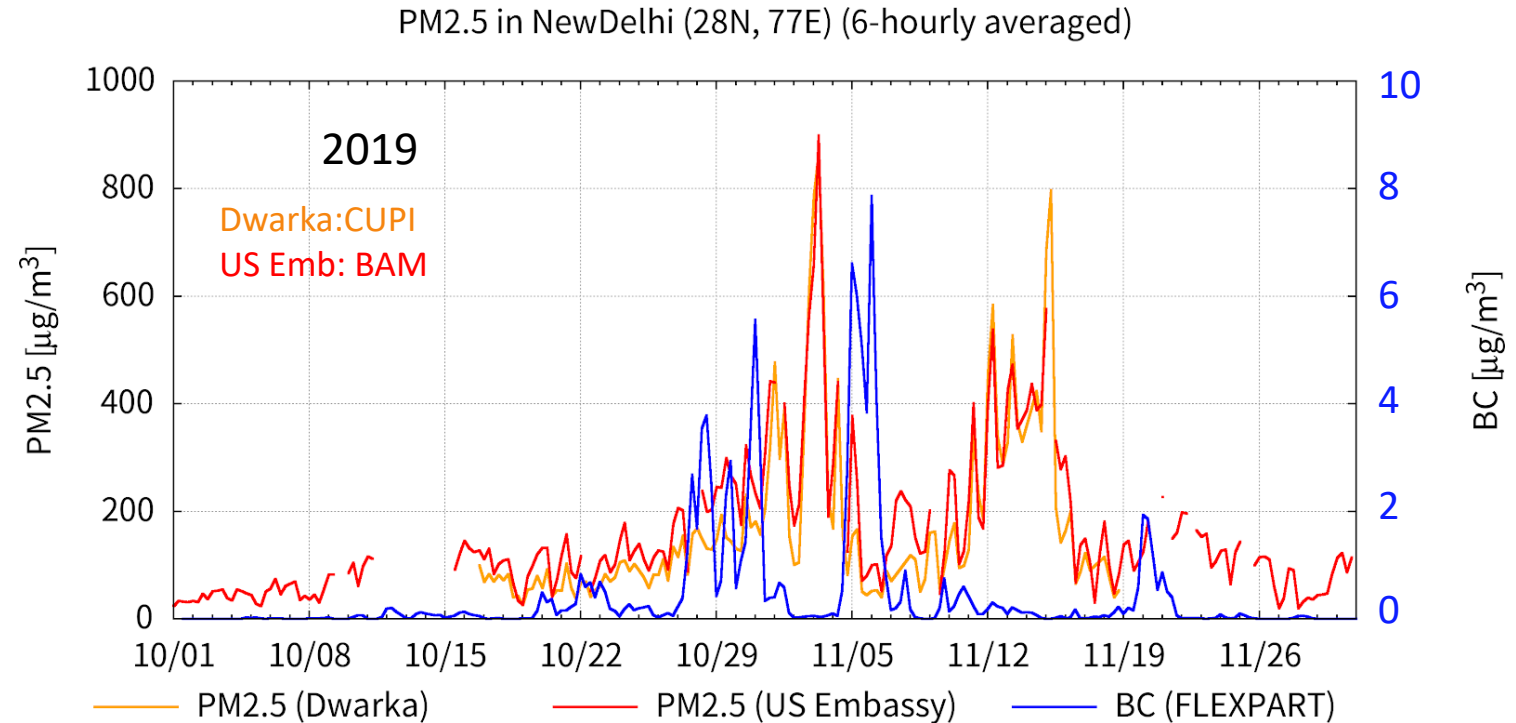
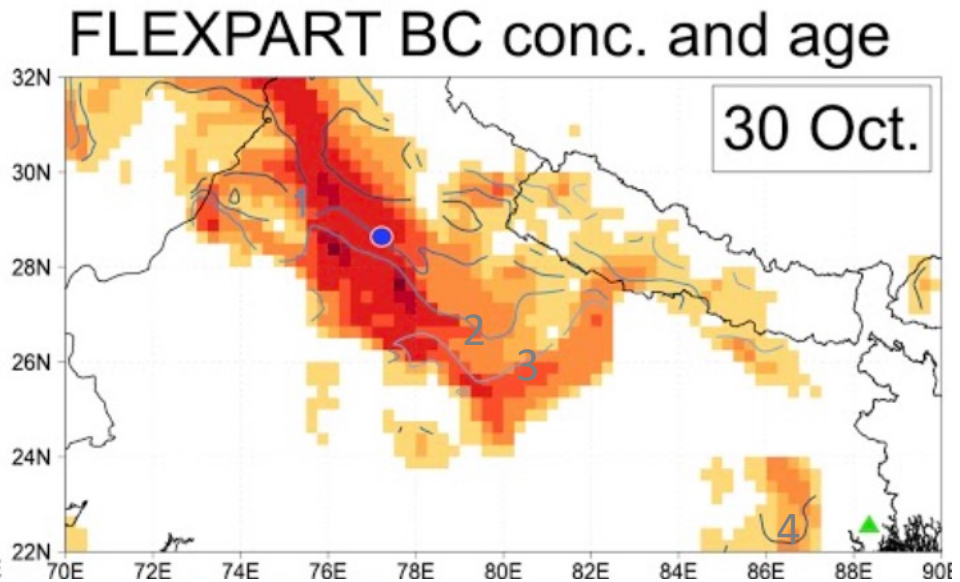
The Punjab Preservation of Subsoil Water Act in 2009 affecting Air Pollution:

1. Solution to one problem caused another – this not for the first time !!
2. Governmental policy works, if implemented well



Can Delhi's pollution be affected by crop fires in the Punjab region?

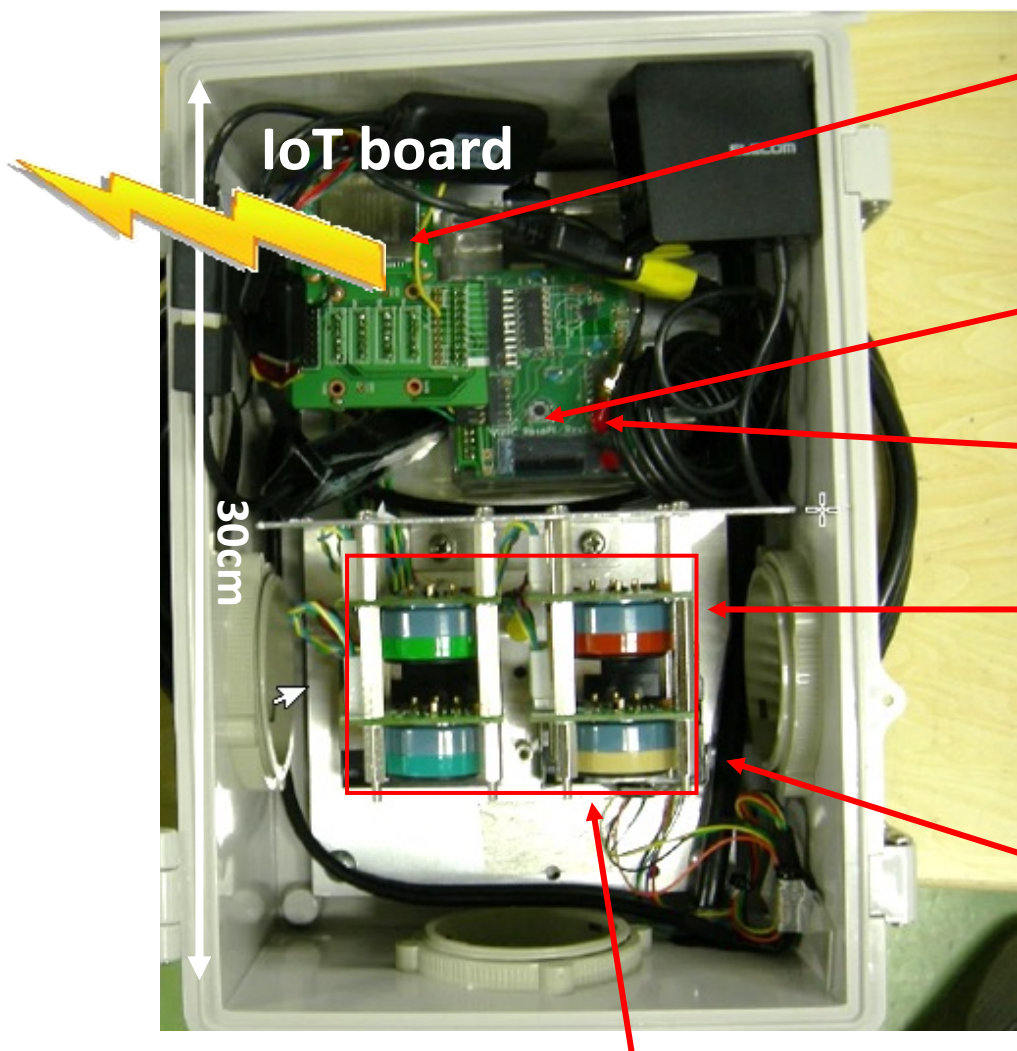
Takigawa et al., SOLA, 2020



1. insufficient information on emission sources because the biomass burning emission based on MODIS FRP significantly degraded by the existence of hazy clouds
2. it is desirable to establish a dense measurement network between Punjab and Delhi for the early detection of the source signals of aerosol emissions and their transport
3. The FLEXPART model simulation shows the transport of emission signals from Punjab to Delhi, which further expands toward the Bengal region within a span of two days.

The instrument for PM_{2.5} and pollutant gases: specially designed for the Aakash project

CUPI-G



SIM card
Transfer data
to the internet server
via mobile phone network

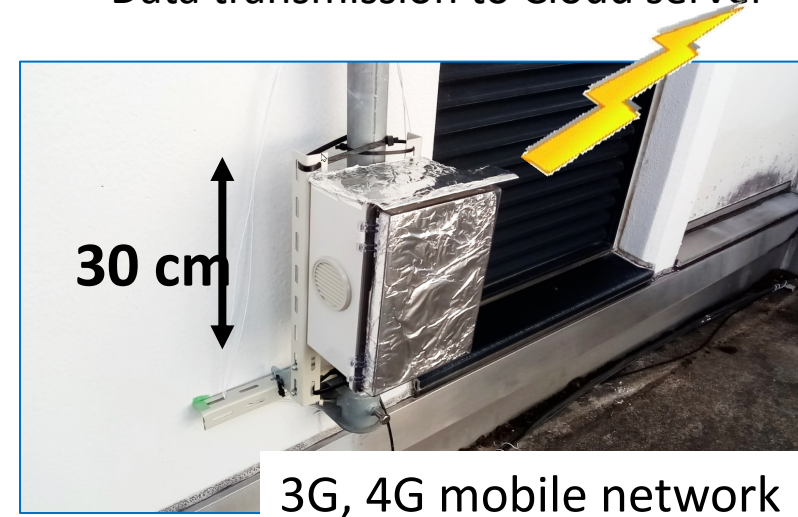
Raspberry Pi A+ (CPU)

GPS antenna

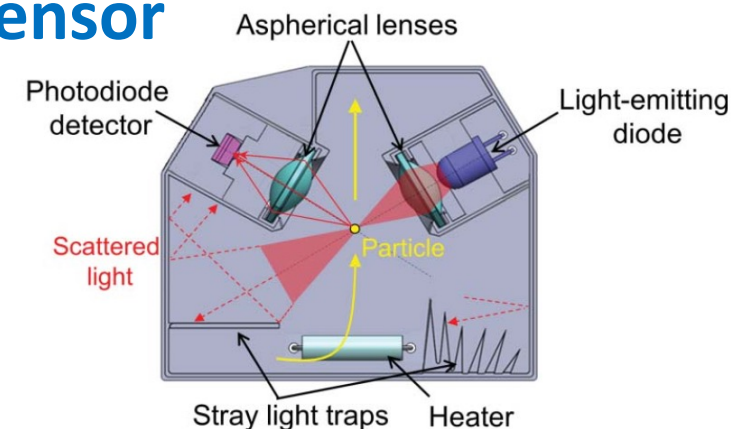
Electro-chemical sensors
Alphasense corp.
CO, NO₂, NO, Ox(=O₃+NO₂)

Temp. and Humid.
Sensors

Data transmission to Cloud server



P-sensor



PM_{2.5} sensor (Developed by Nagoya Univ. and Panasonic Corp.)
Nakayama et al., Aerosol Sci. Tech., 2018

Yutaka Matsumi (Nagoya U.) and Tomoki Nakayama (Nagasaki U.)

Measurement networks

Tanbir Singh et al., submitted

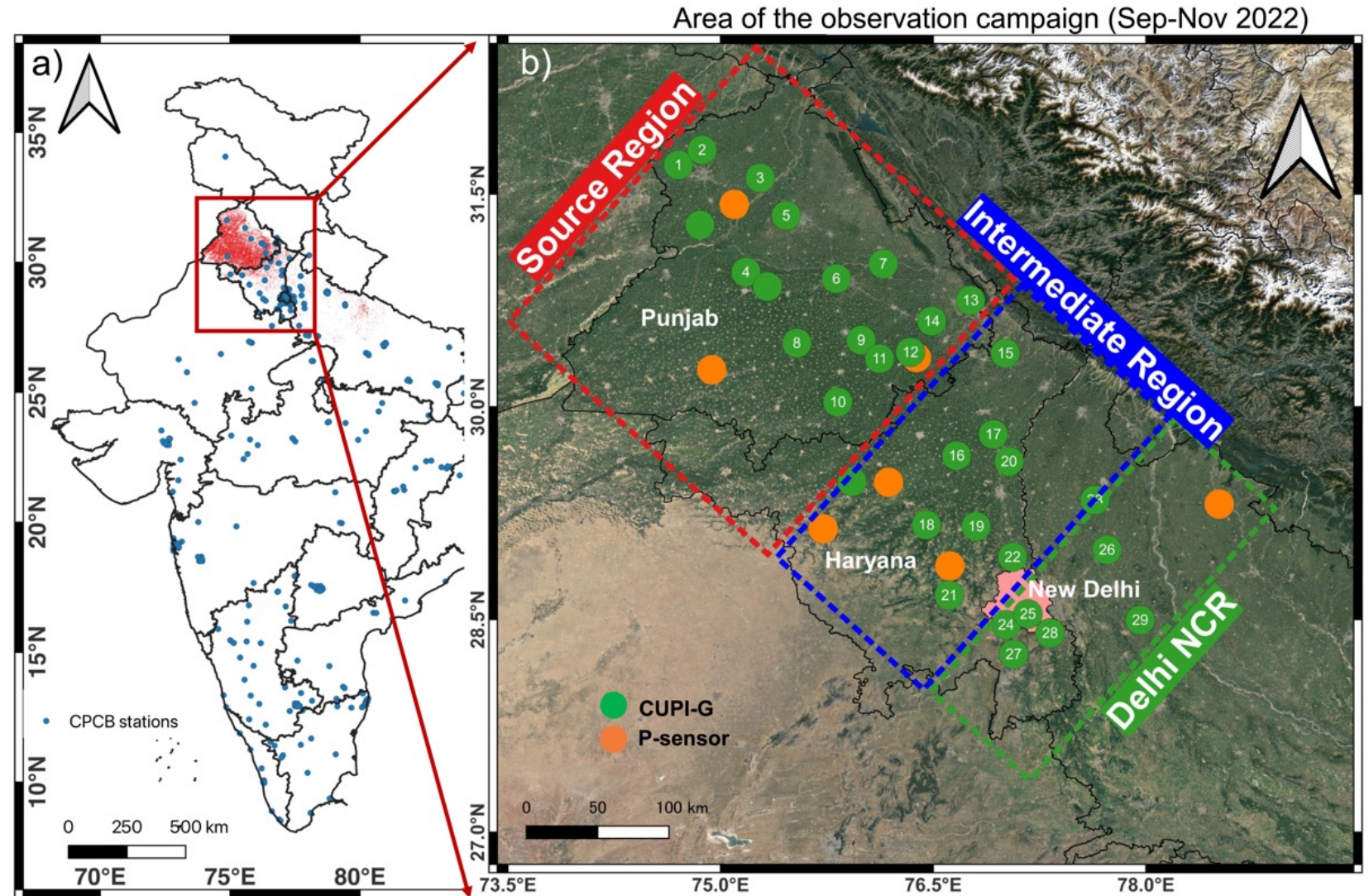
SAFAR-India

<http://safar.tropmet.res.in>

Central Pollution Control
Board: CPCB (India)

US Embassy

JP Embassy...



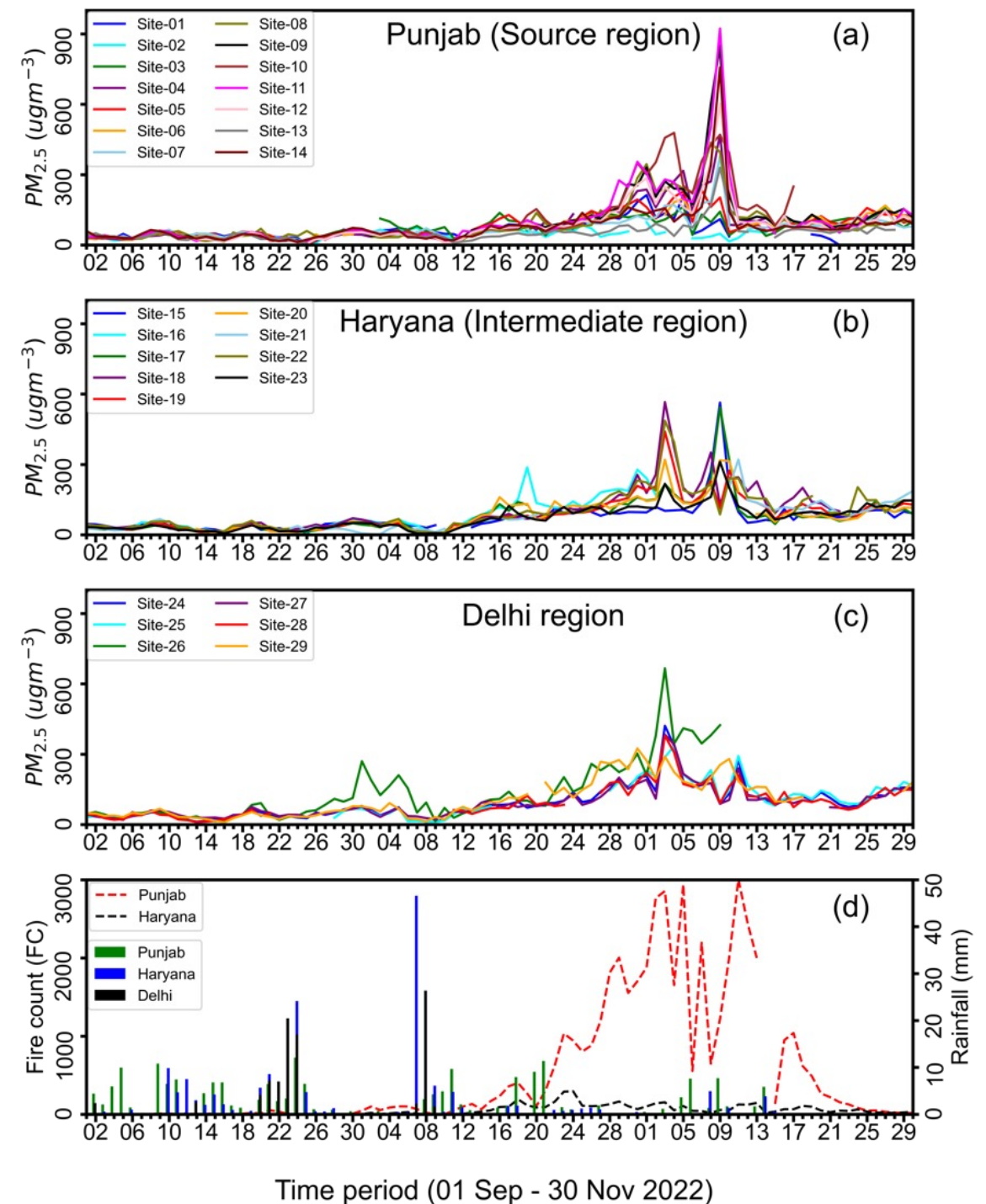
Daily-mean PM_{2.5} variations in Punjab, Haryana and Delhi

Campaign period : 01 Sept - 30 Nov

Daily mean PM_{2.5} concentrations over different regions, i.e. Punjab (source), Haryana (intermediate) and Delhi regions

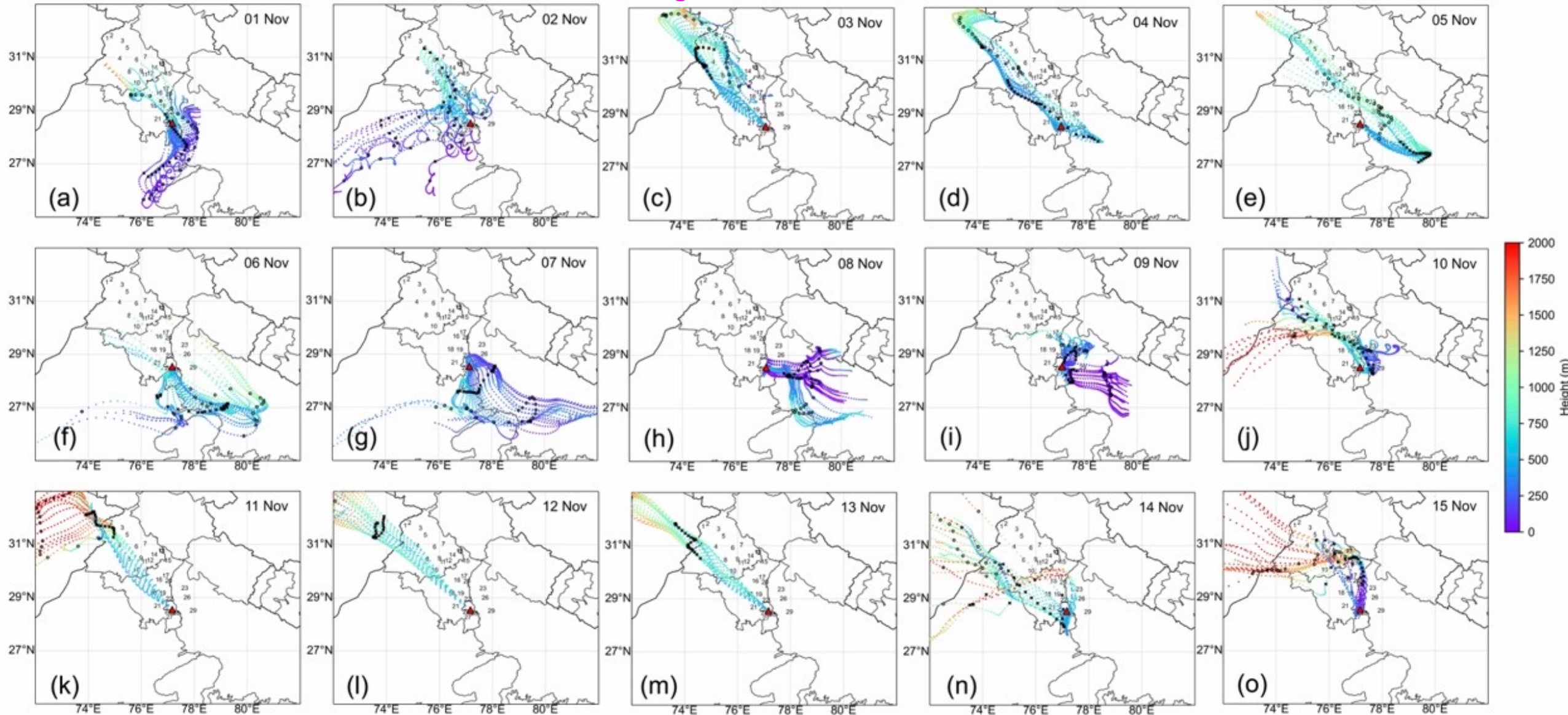
Daily VIIRS based fire counts and over Punjab and Haryana show a good correspondence overall, *but conspicuously low values on 5 and 8 November when PM_{2.5} values are reaching 900 $\mu\text{g m}^{-3}$ at some sites in Punjab*

Global Satellite Mapping of Precipitation (GSMaP) suggests lower PM_{2.5} on the days of rainfall

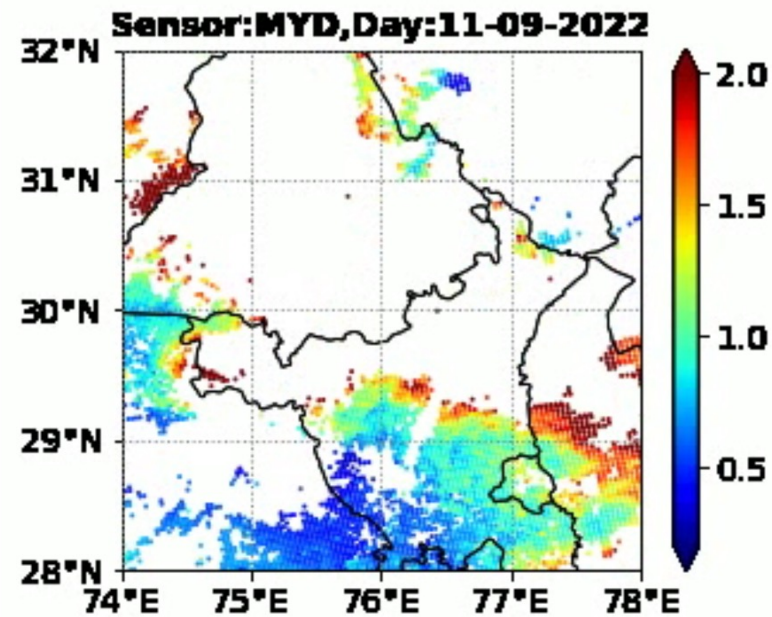
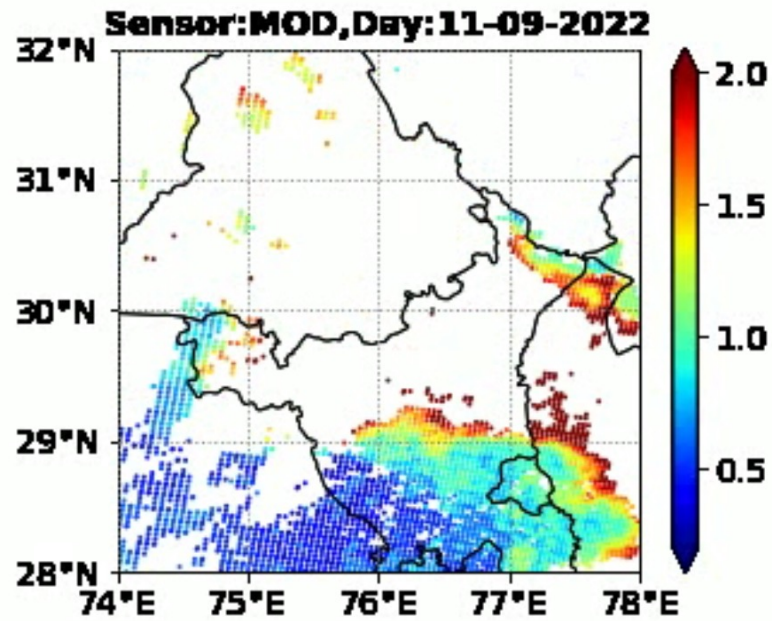


Analysis of transport pathways of PM_{2.5} to Delhi – selection of sites

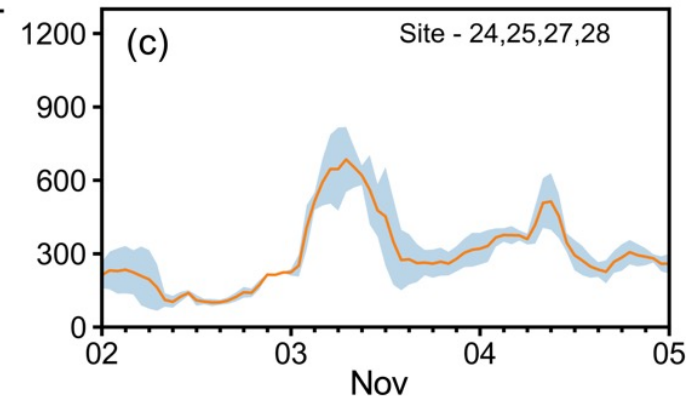
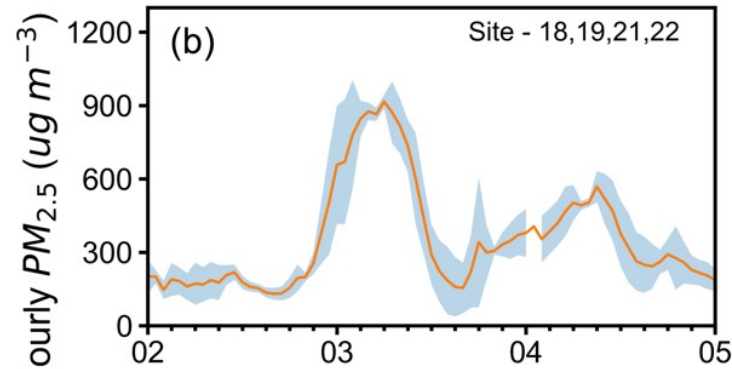
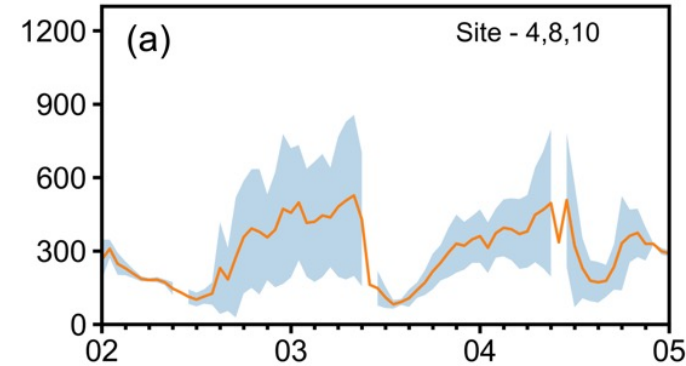
Tanbir Singh et al., submitted



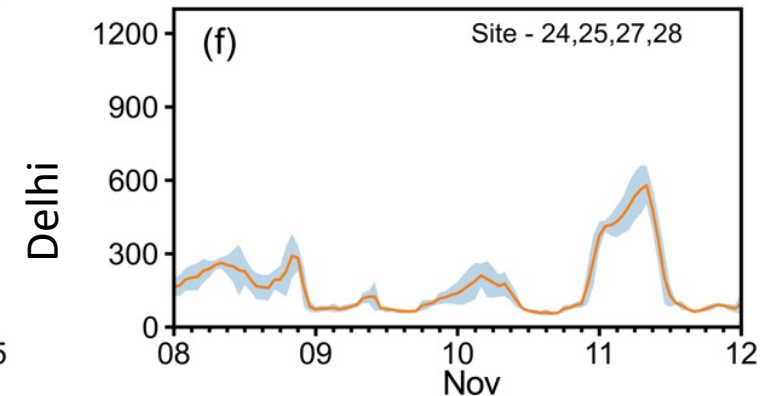
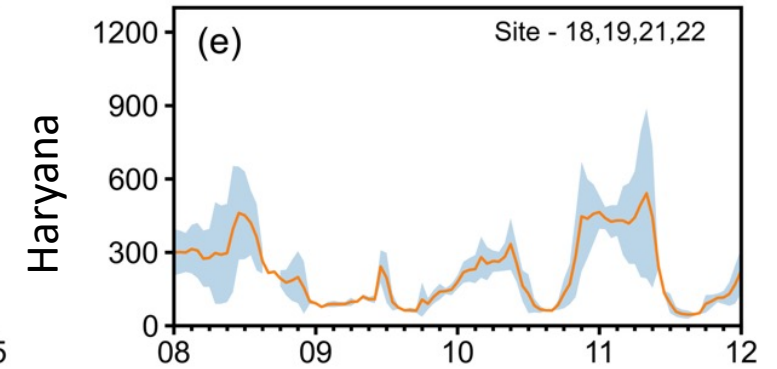
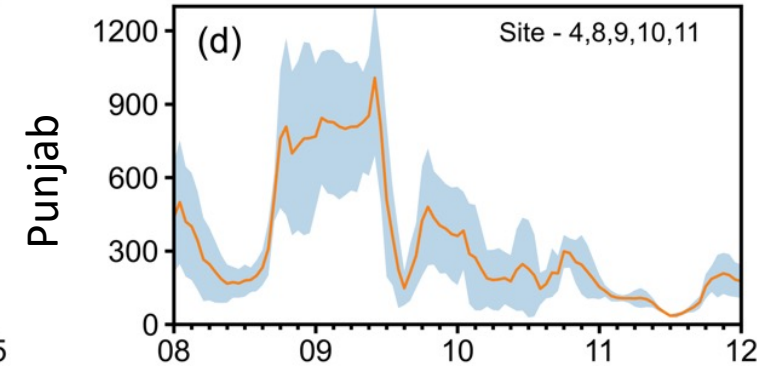
Aakash (CUPI) measurements



Event 1 : high fire counts

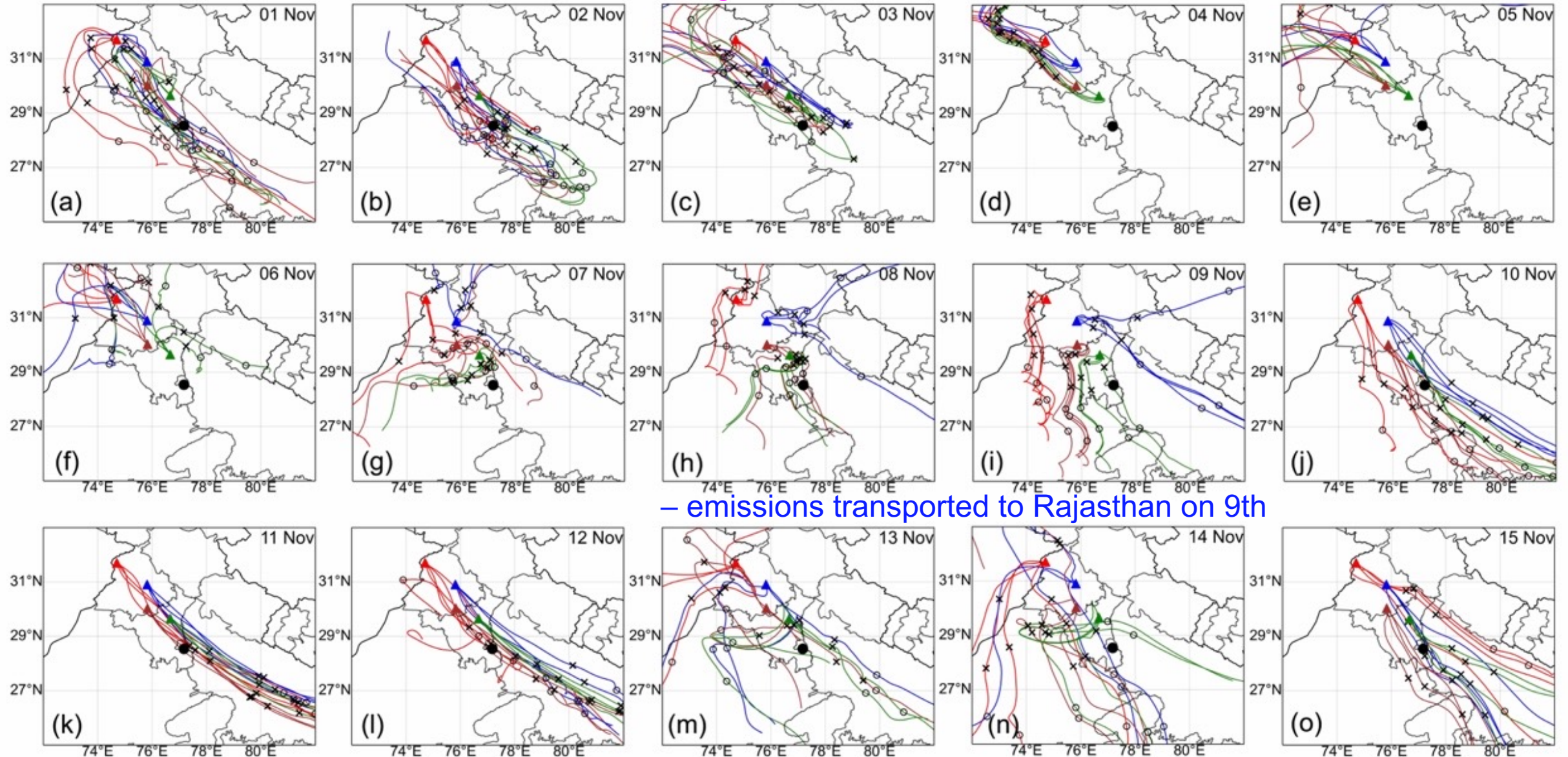


Event 2 : low fire counts



How meteorology plays role in PM_{2.5} transported and pollution build-up

Tanbir Singh et al., submitted

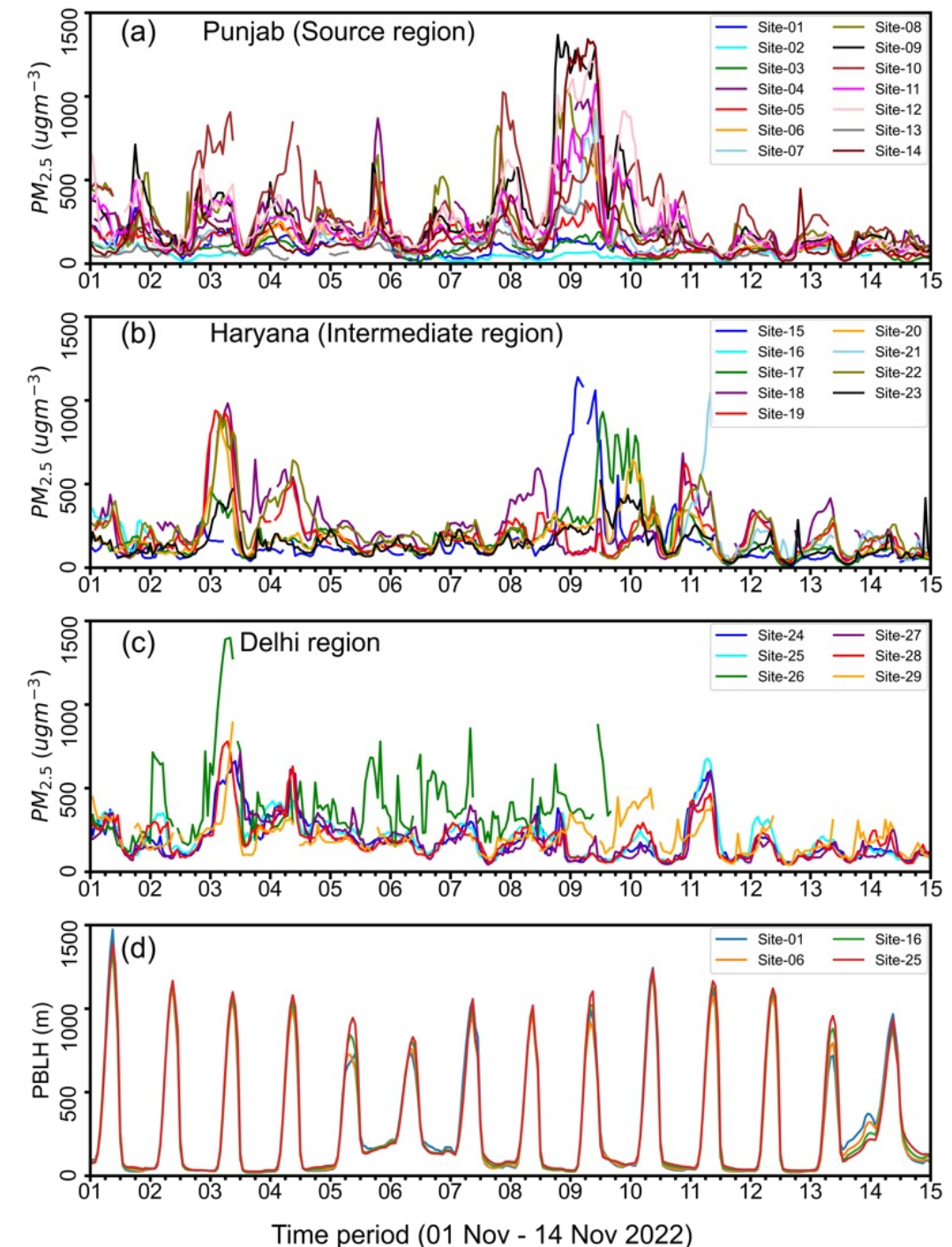


Hourly variations of PM_{2.5}

Hourly PM_{2.5} during 01-14 November 2022 show quite different variations between sites within each of the states

Our results suggest emission inventories must have at least daily time resolution for better understanding of the pollution transport

Emissions and transport of two high PM_{2.5} pollution events on 2-3 November and 8-11 November are to be analysed using models



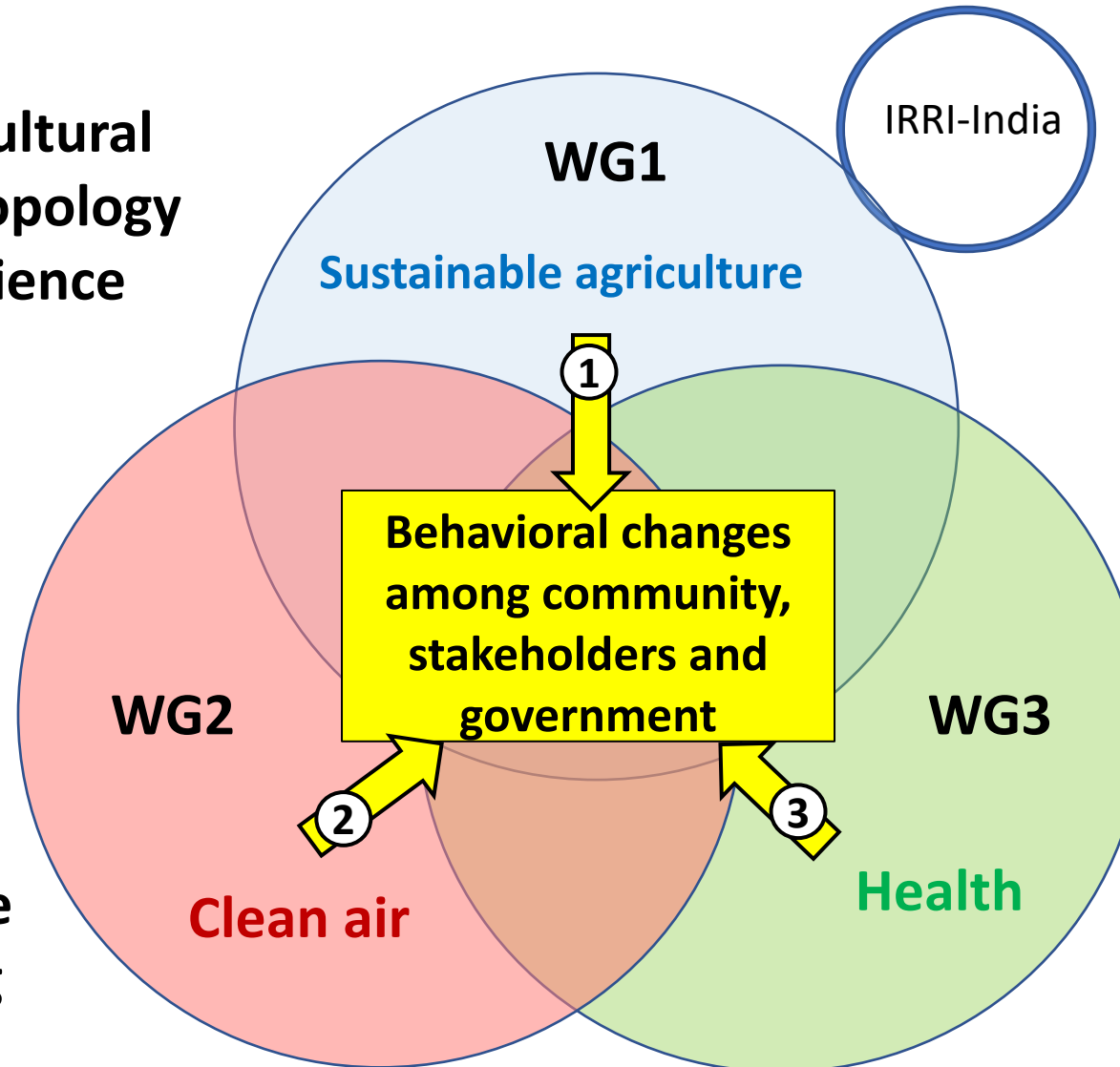
Structure of Aakash and the overarching goals

By
Sachiko Hayashida

**Agro-Economics, Cultural
Geography, Anthropology
and Agricultural Science**

**Atmospheric Science
and Remote Sensing**

WG1c: new group
to survey straw use
for biofuel



**Epidemiology and
Public Health**

We are looking forward to working with the interested parties to better understand the Delhi/India/SouthAsian air pollution



Juichi Yamagiwa

(Social Ecology / Human Evolution / Anthropology)

2021 - Present

Director-General, Research Institute for Humanity and Nature

2014 – 2020 President, Kyoto University

The Research Institute for Humanity and Nature (RIHN), established in April 2001, is an inter-university research institute promoting comprehensive research in global environmental studies.

RIHN Philosophy and Approach

RIHN research starts from the premise that **environmental problems are rooted in human culture and societal values**. RIHN's goal is to seek concepts, theories and mechanisms that enhance human quality of life in direct relation to environmental conditions and ecological processes. RIHN research therefore involves a normative dimension, as it asks what the relationship between humanity and nature ought to be. To this end, RIHN solicits, funds, and hosts integrative research projects investigating environmental change problems in specific settings. Research projects are undertaken by interdisciplinary teams at RIHN, working together with partner institutions and communities in Japan and abroad.

https://www.chikyu.ac.jp/rihn_e/about.html

Conclusions

- We have unique measurements covering the source regions of crop residue (rice straw) burning in the post-monsoon season
 - Daily and hourly PM_{2.5} values reaching up 900 and 14 $\mu\text{g m}^{-3}$ in the Punjab area
 - Daily PM_{2.5} values reaching up to 14 $\mu\text{g m}^{-3}$ in the Punjab area
- Measurements suggest PM_{2.5} plumes from Punjab spread across the neighbouring region depending on wind direction
- Various government policies are needed to tackle the issues of air pollution in the rural and city areas of South Asia

Thank you