# Assessing the variability in emissions from crop residue burning in north India using remote sensing data

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## Background

- India is an agrarian country and produces a large amount of agricultural waste. Rice-wheat crop rotation is commonly practiced in the IGP (Indo-Gangetic Plain).
- Major portion of crop residue burning is from Punjab and Haryana district.
- A high-resolution emission inventory is developed at a spatial resolution of (3×3) km for estimating the biomass burning emissions in each grid in Punjab and Haryana.

## Methodology

- The emissions from open biomass burning of crop residue, shrubland, forest and grassland is calculated using different satellite MODIS products in grids of (3×3) kmduring 2008-2017 in order to analyze their spatial and temporal variability.
- Total burned area is estimated with the use of two MODIS satellite data products i.e., MODIS burned area (MCD64A1) having resolution of 500m and MODIS active fire product (MOD14A1) having spatial resolution of 1km which can detect fires up to 1/20 of a pixel (Randerson et al., 2012)
- After detecting the burned area, the emissions of major pollutants were estimated. Some factors were considered for estimating the emissions like the satellite burned area detected along with emission factors of different pollutants, local biomass distribution and the fuel loading.

## Results

- The average $CO_2$ and CO emissions during 2008-17 are shown in Fig.1. In Punjab, using top-down approach the average emissions of CO, $PM_{2.5}$, $PM_{10}$ are 1791.6 Gg, 153.3 Gg, 173.6 Gg, respectively and using bottom-up approach emissions are 1133.7 Gg, 117.2 Gg, 120.7 Gg, respectively.
- In Haryana, using top-down approach, the average emissions of CO, $PM_{2.5}$, $PM_{10}$, are 804.9 Gg, 68.9 Gg, 78.0 Gg, respectively and using bottom-up approach emissions of CO, $PM_{2.5}$, $PM_{10}$, are 28.2 Gg, 26.4 Gg, 214.0 Gg respectively.
- In Haryana, the major contribution of emissions is from Fatehabad district followed by Karnal and Kaithal district.
- In Punjab, the peak emissions from Sangrur district followed by Patiala and Ludhiana district.

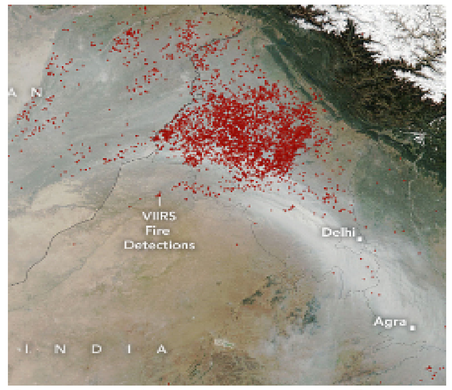


**Fig 1:** Image showing burning spots in Punjab and Haryana

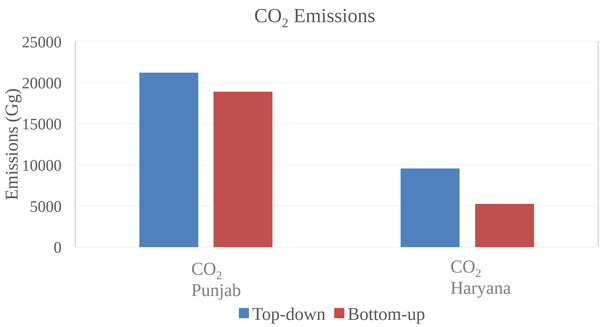


**Fig 2:** Averaged $CO_2$ emissions in Punjab and Haryana during 2008-17

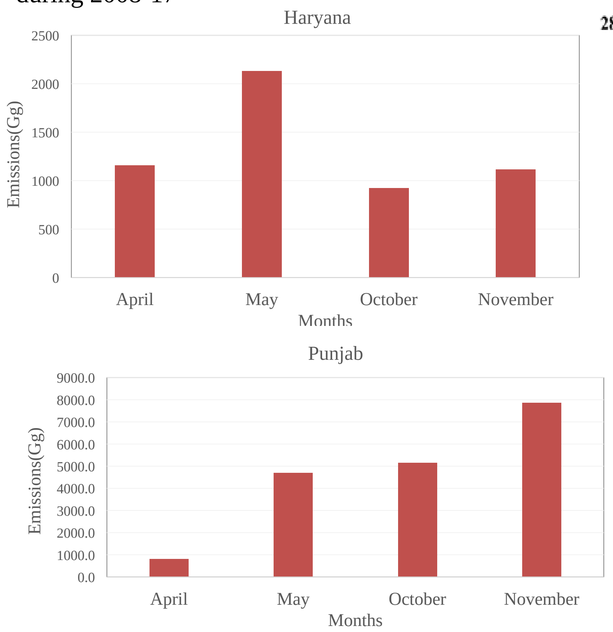


**Fig 3:** Averaged Monthly $CO_2$ emissions in Punjab and Haryana during 2008-17

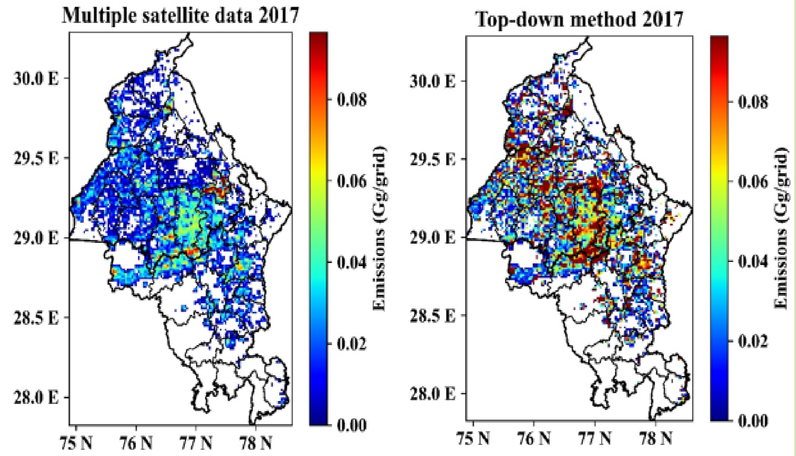


**Fig 4:** Spatial variation of emissions in Punjab and Haryana for 2017

## Conclusions

- The emissions for the study area are also estimated using top-down approach where the crop residue burned is determined using IPCC (Intergovernmental Panel on Climate Change) guidelines and compared with bottom-up approach.
- From the results, it is observed that the top-down approach overestimates the emissions when compared to the bottom-up approach.
- The $CO_2$ emissions calculated using top-down approach is 1.1 and 1.8 times higher than the bottom-up approach for Punjab and Haryana, respectively due to the fixed value of fraction of biomass burnt taken to estimate the amount of crop residue burned

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**References**

1. Randerson, J. T., Y. Chen, G. R. Van Der Werf, B. M. Rogers, and D. C. Morton. "Global burned area and biomass burning emissions from small fires." Journal of Geophysical Research: Biogeosciences 117, no. G4 (2012).
2. Figure 1- (https://earthobservatory.nasa.gov/images/149086/a-shot-of-smoke-for-delhi)