Title:	Residential heating emissions (can) exceed paddy-residue burning emissions in rural northwest India
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Keywords:	Residential heating emissions Paddy harvesting
Issue Date:	2022
Publisher:	Elsevier
Citation:	Atmospheric Environment, 269(1), 118846
Abstract:	November onwards, the poor air quality over northwest India is blamed on the large-scale paddy residue burning in Punjab and Haryana. However, the emission strength of this source remains poorly constrained due to the lack of ground-based measurements over rural areas and issues in the satellite detection of paddy residue fires. In this study, we report the particulate matter (PM) measurements at Nadampur, a village in the Sangrur district with the highest reported paddy residue fires, from 1 October to 19 December 2019, using the Airveda low-cost PM sensors. The daily average PM10 and PM2.5 mass concentration at Nadampur correlated well with the daily sum of Visible Infrared Imaging Radiometer Suite (VIIRS) fire counts (r > 0.7) in a 50 km × 50 km area surrounding the village. Agreement of the Coefficient of Emissions (Ce) estimated in this study (0.038 kg MJ−1) with the reported value (0.04 kg MJ−1), and a disagreement of the top-down estimate of PM emission factors with the laboratory reported values indicates an underdetection of paddy residue fires. Residential burning of solid fuels such as cow-dung cakes and fuelwood for space heating triggered by a dip in the temperature led to poor air quality from 20 November onwards. Source apportionment performed using Multiple Linear Regression (MLR) and Positive Matrix Factorization (PMF) revealed that paddy residue burning increased the PM10 (PM2.5) at Nadampur by 97.0 ± 36.6 μg m−3 (53.4 ± 16.8 μg m−3) which was more than harvesting activities 44.8 ± 1.7 μg m−3 (20.1 ± 5.2 μg m−3), but less than residential heating emissions 151.2 ± 47.2 μg m−3 (120.1 ± 8.8 μg m−3). Unlike agricultural activities, which typically affect the air quality for roughly one month, heating-related emissions profoundly impact the air quality for multiple months.
Description:	Only IISER Mohali authors are available in the record
URI:	https://doi.org/10.1016/j.atmosenv.2021.118846 (https://doi.org/10.1016/j.atmosenv.2021.118846) http://hdl.handle.net/123456789/4823 (http://hdl.handle.net/123456789/4823)
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