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Title: Source apportionment of volatile organic compounds in the northwest Indo-Gangetic Plain using a positive matrix factorization model

Authors: Pallavi (/jspui/browse?type=author&value=Pallavi)
Sinha, B. (/jspui/browse?type=author&value=Sinha%2C+B.)
Sinha, V. (/jspui/browse?type=author&value=Sinha%2C+V.)

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Abstract: In this study we undertook quantitative source apportionment for 32 volatile organic compounds (VOCs) measured at a suburban site in the densely populated northwest Indo-Gangetic Plain using the US EPA PMF 5.0 model. Six sources were resolved by the PMF model. In descending order of their contribution to the total VOC burden these are "biofuel use and waste disposal" (23.2 %), "wheat-residue burning" (22.4 %), "cars" (16.2 %), "mixed daytime sources" (15.7 %) "industrial emissions and solvent use" (11.8 %), and "two-wheelers" (8.6%). Wheat-residue burning is the largest contributor to the total ozone formation potential (32.4 %). For the emerging contaminant isocyanic acid, photochemical formation from precursors (37 %) and wheat-residue burning (25 %) were the largest contributors to human exposure. Wheat-residue burning was also the single largest source of the photochemical precursors of isocyanic acid, namely, formamide, acetamide and propanamide, indicating that this source must be most urgently targeted to reduce human concentration exposure to isocyanic acid in the month of May. Our results highlight that for accurate air quality forecasting and modeling it is essential that emissions are attributed only to the months in which the activity actually occurs. This is important for emissions from crop residue burning, which occur in May and from mid-October to the end of November. The SOA formation potential is dominated by cars (36.9 %) and two-wheelers (21.1 %), which also jointly account for 47% of the human class I carcinogen benzene in the PMF model. This stands in stark contrast to various emission inventories which estimate only a minor contribution of the transport sector to the benzene exposure (~10 %) and consider residential biofuel use, agricultural residue burning and industry to be more important benzene sources. Overall it appears that none of the emission inventories represent the regional emissions in an ideal manner. Our PMF solution suggests that transport sector emissions may be underestimated by GAINSv5.0 and EDGARv4.3.2 and overestimated by REASv2.1, while the combined effect of residential biofuel use and waste disposal emissions as well as the VOC burden associated with solvent use and industrial sources may be overestimated by all emission inventories. The agricultural waste burning emissions of some of the detected compound groups (ketones, aldehydes and acids) appear to be missing in the EDGARv4.3.2 inventory.

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