

Investigating the Impact of VOC Sources during Different Seasons on the Air Quality of a Metropolitan Region in India

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Abstract

Volatile organic compounds (VOCs) play a crucial role in influencing the air quality of the urban atmospheres, especially in nitrogen oxide (NOx) dominated regions like India. Additionally, the associated direct health risks necessitate the identification of VOC sources and their contribution to the VOC budget of a region. This study presents the seasonal variability of VOCs measured using a Proton Transfer Reaction Quadrupole Mass Spectrometer (PTR-QMS) during the year 2019 over the metropolitan Pune region. Also, the VOC sources have been identified using the US EPA PMF 5.0 model for different seasons. Toluene (summer: 2 $\mu\text{g}/\text{m}^3$, monsoon: 1.11 $\mu\text{g}/\text{m}^3$, winter: 7 $\mu\text{g}/\text{m}^3$), o-Xylene (summer: 1.41 $\mu\text{g}/\text{m}^3$, monsoon: 1.24 $\mu\text{g}/\text{m}^3$, winter: 5.67 $\mu\text{g}/\text{m}^3$), Acetaldehyde (summer: 2.80 $\mu\text{g}/\text{m}^3$, monsoon: 1.84 $\mu\text{g}/\text{m}^3$, winter: 5.10 $\mu\text{g}/\text{m}^3$) and Acetone (summer: 5.95 $\mu\text{g}/\text{m}^3$, monsoon: 2.58 $\mu\text{g}/\text{m}^3$, winter: 6.21 $\mu\text{g}/\text{m}^3$) were found to be the prominent anthropogenic source-based emissions apart from Methanol (summer: 8.68 $\mu\text{g}/\text{m}^3$, monsoon: 5.24 $\mu\text{g}/\text{m}^3$, winter: 7.72 $\mu\text{g}/\text{m}^3$) which mostly has a biogenic source. While most of the identified sources (vehicular emissions, biomass burning, biogenic emissions, photochemical secondary products) are common throughout the year, their contribution to the total measured VOCs across seasons has varied considerably (9-17%, 8-12%, 5-14%, 19-27% respectively). Of the resolved factors, ozone formation potential (OFP) was found to be highest for photochemical secondary products (26%) during all the seasons, followed by vehicular emissions (23%) and background emissions (17%). The sources identified in this work are in agreement with a recent bottom to top emission inventory developed for the region which shows vehicular emissions as a dominant VOC source. This work highlights the role of meteorology in varying the VOCs concentration over the Pune region and eventually the local air quality.

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ABSTRACT

Volatile organic compounds (VOCs) play a crucial role in influencing the air quality of the urban atmospheres, especially in nitrogen oxide (NO_x) dominated regions like India. Additionally, the associated direct health risks necessitate the identification of VOC sources and their contribution to the VOC budget of a region. We have here presented the seasonal variability of VOCs measured using a Proton Transfer Reaction Quadrupole Mass Spectrometer (PTR-QMS) during the year 2019 over the metropolitan Pune region. Also, the VOC sources have been identified using the US EPA PMF 5.0 model for different seasons. Toluene (summer: 2 µg/m³, monsoon: 1.11 µg/m³, winter: 7 µg/m³), o-Xylene (summer: 1.41 µg/m³, monsoon: 1.24 µg/m³, winter: 5.67 µg/m³), Acetaldehyde (summer: 2.80 µg/m³, monsoon: 1.84 µg/m³, winter: 5.10 µg/m³) and Acetone (summer: 5.95 µg/m³, monsoon: 2.58 µg/m³, winter: 6.21 µg/m³) were found to be the prominent anthropogenic source-based emissions apart from Methanol (summer: 8.68 µg/m³, monsoon: 5.24 µg/m³, winter: 7.72 µg/m³) which mostly has a biogenic source. While most of the identified sources (vehicular emissions, biomass burning, biogenic emissions, photochemical secondary products) are common throughout the year, their contribution to the total measured VOCs across seasons has varied considerably (9-17%, 8-12%, 5-14%, 19-27% respectively). Of the resolved factors, ozone formation potential (OFP) was found to be highest for photochemical secondary products (26%) during all the seasons, followed by vehicular emissions (23%) and background emissions (17%). The sources identified in this work are in agreement with a recent bottom to top emission inventory developed for the region which shows vehicular emissions as a dominant VOC source. This work highlights the role of meteorology in varying the VOCs concentration over Pune region and eventually the local air quality.