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Spatio-temporal characterization of tropospheric ozone and its precursor pollutants NO_2 and HCHO over South Asia

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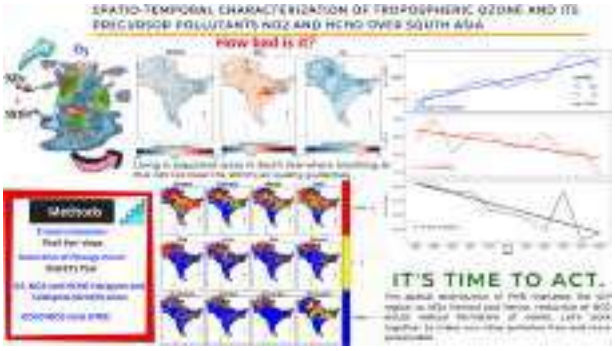
HIGHLIGHTS

- Recent satellite based measurements for O_3 and its precursors HCHO and NO_2 during 2008-18 over South Asia were assessed.
- We retrieved data from EUMESAT/METOP-A IASI tropospheric Ozone (O_3) and Aura/OMI satellite tropospheric NO_2 & HCHO.
- Theil Sen' slope; change point detection, O_3, NO_2 and HCHO hotspots & coldspots identified, and HCHO/NO_2 ratio (FNR)
- The Indo-Gangetic Plains (IGP) emerged as being critically affected by the three trace gases.

GRAPHICAL ABSTRACT



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ABSTRACT

In recent decades, South Asia has experienced declining air quality, with much of the attention being focused on extremely high levels of particulate matter. Here, we analyze tropospheric ozone (O_3), formaldehyde (HCHO), and nitrogen dioxide (NO_2) to assess other measures of air quality across South Asia from 2008 to 2018. The IASI-Forli retrieved tropospheric ozone data was validated with ozonesonde, reanalysis (ERA5), satellite (TES), and model simulation products (GEOS-Chem and TOMCAT/SLIMCAT). Space-based observations of these three trace gases were used to conduct a spatio temporal analysis over South Asia using trend analysis (Theil-Sen and linear regression), change-point detection (Pettitt's test), and hotspot identification (Getis-Ord G_i^*). We used the formaldehyde-nitrogen dioxide ratio (FNR) to identify NO_x limited, VOC limited, and transitional regimes in South Asia. Counter to previous studies, a statistically significant decrease of HCHO (−0.0041 DU yr^{-1}) and O_3 (−0.064 DU yr^{-1}) was detected for South Asia; however, NO_2 is increasing the 0.001 DU yr^{-1} over South Asia during 2008–18. The Indo-Gangetic Plains emerged as being critically affected by the three trace gases. Certain parts of southern and south-eastern India are gradually emerging as NO_2 and HCHO hotpots. No significant O_3 hotspots were discernible, though coldspots existed along the Himalaya belt of India, Nepal, and Bhutan and mountainous tracts of Pakistan. FNR indicates the reduction of NO_x in NO_x-limited regime of the Indo-Gangetic Plains reduced the formation of tropospheric O_3 over South Asia.

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