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# Source apportionment of surface-level trace gases and particulate matter at three tropical coastal sites in India

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Over last two decades, South Asia has witnessed a rapid increase in population, industrialization, and energy demands. Consequently, 2-6 fold increase in the emission of particulate matter (PM) and trace gases were reported. Air pollution in South Asia has more adverse impact and is linked to nearly 1 million premature deaths and around 10 million tonnes of crop loss in a year. So, monitoring of trace gases and PM concentrations over urban centers has received significant attention among scientists, policymakers, health regulatory agencies, and the media. Particularly over the Indian region, this becomes significant, as the observation of trace gases and PM concentrations with fairly good temporal and spatial resolutions is limited. Concerns about air quality and transport pathways on a regional scale also place more stringent demand on observations and modeling effort. Quantifying the source contribution (regional emission due to various anthropogenic activities such as city traffic density vs. long-range transport due to meteorological influence) of trace gases and PM over different temporal and spatial scales has been receiving significant attention. In view of this, measurement of trace gases and PM in concurrence with meteorological variables (wind speed and direction) is of paramount importance.

In this study, we have presented three-year surface measurements of TGs ($O_3$, CO, $NO_x$, $SO_2$ and $NH_3$) and PMs (PM2.5 and PM10) at three coastal and urban sites, namely, Trivandrum (TVM, 8.5°N, 76.9°E, 5m AMSL), Chennai (CHN, 13.7°N, 80.2°E, 6.7m AMSL) and Bhubaneswar (BHB, 20.2°N, 85.8°E, 45m AMSL) located in India. -In addition to that Ozone Monitoring Instrument OMI's, surface mass concentration data for $SO_2$ and Moderate Resolution Imaging Spectroradiometer (MODIS) fire counts data were also used to identify potential sources. The principal component analysis (PCA) and concentrated weighted trajectories (CWT) were applied to

the dataset. The TGs and PM showed high values during winter and lower values in a monsoon at these sites. Both TGs and PM values were higher at BHB compared to those at TVM and CHN. Surface $O_3$ at BHB was about 3 times higher than that at TVM and 2.2 times higher than that at CHN. Interestingly, PCA suggests that the major concentrations of $O_3$, PM10, and $SO_2$ at TVM and CHN were transported from different locations and not produced locally except for pre-monsoon at CHN, which was of local origin. CWT analysis and OMI's surface mass concentration data also suggest that the air quality at TVM could be influenced by heavy emissions transported from the Indo-Gangetic plain. The Merra-2 reanalysis well captured seasonal variations of TGs and PMs; and it overestimated surface $O_3$, by a factor of about 2 to the measurement at the study sites.