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Levels, variations, and sources of major combustion related emissions in Accra, Ghana

Background. As one of the world's fastest urbanizing regions, rapid economic growth in Sub-Saharan Africa (SSA) is raising levels of urban air pollution from all sources, including from informal industries, transportation, re-suspended dust, and household biomass and trash burning. This diversity of sources in SSA cities produces complex air pollution mixtures, patterns, and huge exposure disparities within cities with likely differential impacts on population health. While measurement data are now emerging from SSA on total mass of particulate matter pollution, there is limited information on population exposure to major combustion related pollutants like nitrogen oxides (NO_(x)) and their relative contributor sources (biomass vs traffic), which is relevant for health-base policy decision to reduce exposures and health impacts. Our aim is to assess in fine resolution the levels, variations, and sources of NO_(x) exposure, and the role of community socioeconomic status (SES) in Accra, Ghana's capital and one of the largest metropolitan areas in SSA.

Methods. We rely on a combination of year-long (fixed sites, n = 10) and week-long (rotating, n = ~140) to collect weekly ambient integrated NO_(x) and NO_(2) samples from ~150 unique locations in Accra, using OGAWA passive samplers. The sampling locations capture a range of land-use variables (e.g. residential, background) and source influences (traffic, biomass, industries) and across seasons (April 2019 – May 2020). The data is being analyzed in relation to various spatial factors (e.g. road types, neighborhood location, population density, and household biomass use) and community SES to identify key determinants and health-based priority areas and sectors for targeted policy intervention.

Results. We have so far analyzed 422 samples from 51 unique sites (10 long-term and 41 rotating). The overall mean ± SD NO_(2) and NO_(x) concentrations were 43 ± 24 (2.2-110) and 120 ± 88 (16-394) μg/m^3. The levels are highest at traffic sites (74 ± 16 and 246 ± 84 μg/m^3 for NO_(2) and NO_(x), respectively) compared to residential sites (38 ± 18 and 93 ± 46 μg/m^3 for NO_(2) and NO_(x), respectively). Lower SES (high population density) neighborhoods, where biomass use is the highest, had mean NO_(2)/NO_(x) of 40/94 μg/m^3 compared to 37/91 μg/m^3 in higher SES (lower population density) neighborhoods. The overall mean ratio of NO_(2)/NO_(x) is 0.38 ± 0.1, varying from 0.34 at traffic sites to 0.39 at non-traffic sites, which is significantly lower than the ratios in North America, Europe and East Asia, indicating a less oxidative atmospheric condition in Accra.

Conclusions. Our study presents the first long-term (year-round) monitoring results of ambient NO_(2)/NO_(x) within different SES communities in a metropolitan city in SSA. Our results suggest that traffic is the most important emission source for NO_(x) in Accra. However, the contribution from biomass burning is also substantial, and people from different SES community are experiencing similar situation.