Background and objective
Cities in the developing world are growing rapidly, particularly in sub-Saharan Africa, with corresponding increases in economic activity and traffic. Little is known about air pollution sources and their relative contributions to air pollution in African cities. The objective of this study is to identify sources of ambient particulate matter (PM) in Accra, Ghana and to characterize the contribution of each source.

Methods
We collected 48-hour PM$_{2.5}$ (aerodynamic diameter less than 2.5 μm) and PM$_{10}$ (aerodynamic diameter less than 10 μm) samples at 11 residential or roadside sites in four neighborhoods of Accra between November 2006 and August 2008. Elemental composition of PM was assessed by performing X-ray fluorescence (XRF). We developed an extended factor analysis method that accounts for spatial and temporal correlation of data and for site-specific covariates. We applied this method to the elemental concentration data for source identification and apportionment.

Results
XRF results show that crustal elements (Al, Si, Fe, Ca, Mg), sea salt elements (Na, Cl), K and S had the highest concentrations at various sites. Source apportionment results indicate that crustal material, road dust, combustion, and sea salt are the four main sources contributing to the observed concentrations in Accra. Crustal material was found to be the most important contributor at each site, followed by combustion. The sea salt factor was seen at each site, with the highest contribution at the site closest to the coast.

Conclusion
Crustal material, road dust, combustion, and sea salt are primary source contributors to PM in urban Accra.