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Polycyclic aromatic hydrocarbons (PAHs) and their nitrated and oxygenated derivatives in air of the Arabian Basin

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Polycyclic aromatic hydrocarbons (PAHs) as well as their nitrated (NPAHs) and oxygenated (OPAHs) derivatives are formed by incomplete combustion of fossil and biofuels. Accordingly, these substances are emitted e.g. by road and ship traffic, various industries, and biomass burning (Bandowe & Meusel, 2017). Besides these primary sources, NPAHs and OPAHs can be formed in the atmosphere from PAHs in atmospheric oxidation reactions (Finlayson-Pitts & Pitts, 2000). Many NPAHs are more toxic (e.g. carcinogenic) than their parent PAHs (IARC, 2012). In addition, quinones, a major subgroup of OPAHs, have received much attention in recent years, as upon inhalation they are effective precursors for reactive oxygen species (ROS) which can have adverse health effects (Walgraeve et al., 2010). Despite their adverse impact on human health, the atmospheric concentrations of NPAHs and OPAHs, their cycling and fate in the environment are not well studied.
The AQABA (Air Quality and Climate Change in the Arabian Basin) project was a comprehensive ship-borne campaign in summer 2017 measuring a wide range of air pollutants, aerosols, atmospheric oxidants and auxiliary parameters over the Mediterranean Sea and the seas around the Arabian Peninsula. Although the region is populous and public health is compromised by heat extremes, atmospheric dust and air pollution, relevant data and knowledge is limited. For this study, active air samplers were applied when the ship was passing different locations including very clean areas (Arabian Sea), highly polluted areas near the coast (from cities and shipping) and the Arabian Gulf area (petrochemical industries). Phase distribution in the atmosphere was addressed by differential sampling of the gas and particulate phase (PM10, size-segregated).
PAHs and NPAHs in the air samples were extracted with organic solvents and identified/quantified by gas chromatography/mass spectrometry (GC/MS), while heavy metals were determined by inductively coupled plasma mass spectrometry (ICP-MS).
PAHs and OPAHs were found in the 100 1000 pg/m^3 range in air over the Red Sea, the Arabian Gulf and the Gulf of Oman. Nitrated PAHs were found in the 1 10 pg/m^3 range in air of the entire region. Source regions and less polluted sites could be differentiated based on the concentrations and composition patterns of PAH and NPAHs. Furthermore, plumes could be identified and attributed to their origin. The heavy metal content in the sampled air reflects both crustal dust and anthropogenic pollution events. The spatial variation of pollutants, composition patterns, mass size distributions and sources in the region will be presented and discussed.