

Trace elements in London aerosol during the Olympic Games 2012

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Air pollution is one of the many issues in large cities that influence the quality of life and the environment. ClearfLo (Clean Air for London) is a large, multidisciplinary and multi-institutional field project with the goal of refining the knowledge of processes and interactions in the atmospheric boundary layer that influence the weather, the atmospheric chemistry and air quality in this megacity. A year long monitoring of atmospheric parameters was complemented by approximately 1-month intensive field campaigns (IOPs) in winter and summer of 2012 (Figure 1), where additional quantities were measured at several sites. During these IOPs we collected size-segregated aerosols with 2-hour time resolution that were subsequently analyzed for their elemental composition at HASYLAB, beamline L (Figure 1), and at the SLS Optics beamline.

An interesting research objective of ClearfLo was whether the Olympic Games had an impact on air quality in London. The summer IOP started on 21 July and ended on 19 August, encompassing the Olympic Games (27 July – 12 August). Specific traffic control measures were in effect during the games to prevent congestion and reduce air pollution in the city. The fireworks of the opening and closing ceremonies emitted a number of mostly metallic elements into the atmosphere that should be observable when weather conditions were right (i.e. when polluted air masses were advected over the measurement station). This demonstrates the crucial role of the weather during the IOP.



Figure 1: Left: The RDI (little green cabinet on top of the white container at right) at Sion Manning School, North Kensington, London, January 2012. Such a setup is characteristic of an integrated, multi-parameter field campaign in atmospheric research. Right: The SR-XRF setup at HASYLAB, beamline L.

Ambient air was sampled with 3-stage rotating drum impactors (RDI). Aerosols were separated into three size classes (stages) from 0.1 – 1.0 μm , 1.0 - 2.5 μm and 2.5 - 10 μm . During the IOPs one RDI was located at a busy traffic site in a street canyon, the other one on a school yard in a residential area (Figure 1), providing urban background concentrations. The sampling interval was 2 h, leading to 96 samples in 8 days per size range. Thus, about 2400 samples were collected during this IOP. The samples were then exposed to a white X-ray beam to determine their elemental composition by X-ray fluorescence spectrometry (XRF). This setup allows for the measurement of elements from Ti to Pb, with a special advantage for the heavier elements, such as Sb, Ba or Pb. Lighter elements from Na to Zn were analysed with monochromatic light and under vacuum at the SLS. The measured spectra were mass-calibrated with ICP-OES measurements of in-house produced calibration standards, and the obtained concentrations were assembled to time series for

each analysed element. The overlap of elements analysed at both beamlines enabled us to test the reproducibility and reliability of the XRF measurements.

The time series of Ba and Sr are shown in Figure 2. The figure shows the high temporal variability of the concentrations at both sites. Ba concentrations are significantly higher at the traffic site. The urban background station shows lower concentrations of most elements compared to the street canyon. The lower part of the figure shows that variations are not always synchronous for the different size ranges. So far, no distinct changes in concentrations were found for the Olympic Games period, but this requires further analyses.

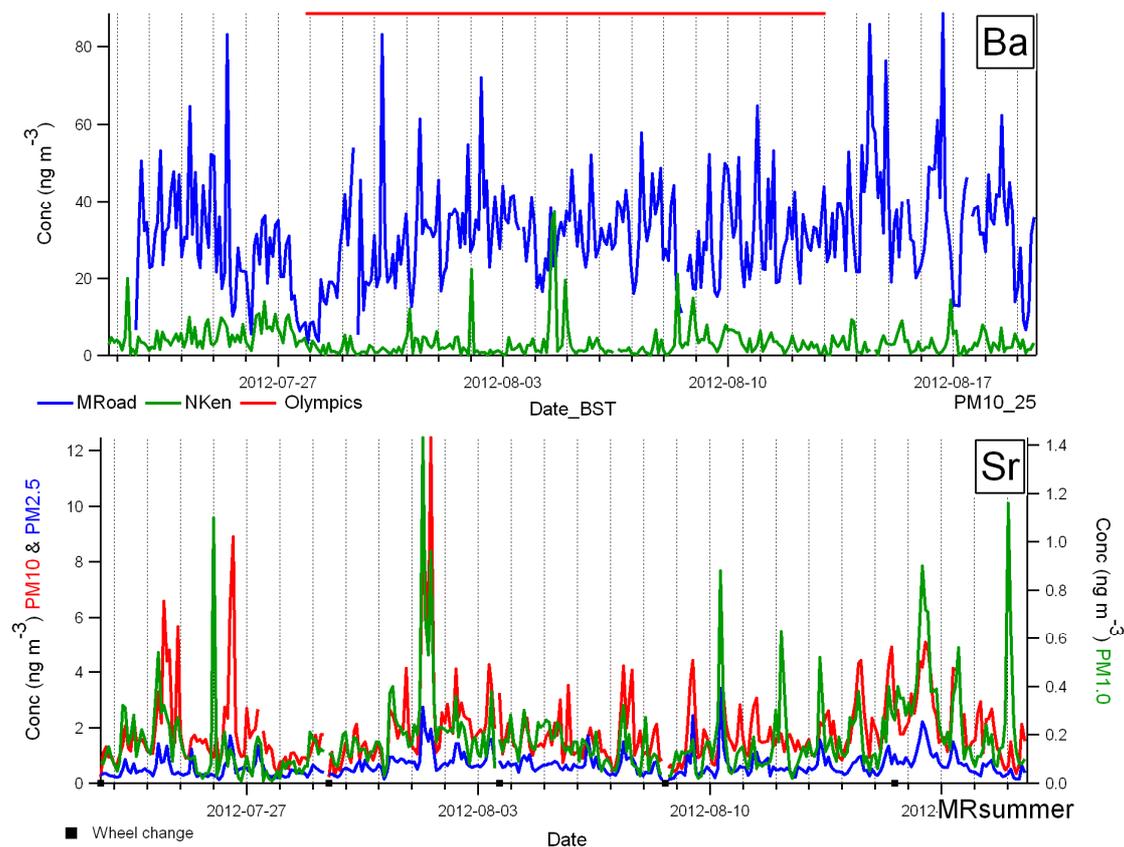


Figure 2: Top: Time series of Ba for the urban background site North Kensington (NKen) and the traffic site Marylebone Road (MRoad), summer IOP 2012. Bottom: Time series of Sr in three size ranges measured at Marylebone Road. The red bar on top of the graph marks the period of the Olympic Games.

An in-depth analysis and source apportionment for the different elements will be performed by applying statistical methods, such as Positive Matrix Factorization and Multi-linear Engine [1, 2]. Before applying these techniques, a detailed intercomparison of the trace elemental data with other chemical measurements is necessary to assess the overall measurement quality. For the integrated field project ClearLo this is feasible, but time-consuming. Only after a rigorous quality assessment will it become possible to answer the questions posed in the introduction.

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References

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