Primary and secondary aerosol sources in Ireland: from relatively clean summer background to extreme winter air pollution

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Introduction

Pollution is currently the largest environmental cause of premature death in the world, being responsible for three times more deaths than epidemics and diseases combined and 15 times more than from all forms of violence (Landrigan et al., 2017). Millions of premature deaths per year are associated with outdoor particulate matter (PM) air pollution globally (Lelieveld et al., 2015). Mass concentration, however, is not sufficient to evaluate the health effects of PM. Some chemical components and sources can be more harmful than others. Moreover, primary and secondary aerosols can have different health effects and contribute with different proportions to total PM mass depending on dominant sources and efficiency of photochemical production, which, in turn, depends on season and location.

Results

Here we present the results from Irish national transboundary air pollution network with 3 aerosol mass spectrometer nodes delivering near real-time speciation of PM data and subsequent source apportionment. The network reveals that, during cold, stagnant conditions in Dublin, PM1 mass concentrations can reach up to 300 μg m^{-3} of which 70% comes from organics, and approximately 90% when considering carbonaceous aerosol (organic matter and black carbon combined) as a whole (Lin et al., 2018). Moreover, consumption of peat and wood, even though contributing to a minor part of city's energy budget, can cause up to 70% of particulate mass pollution. In contrast, during summer, secondary sources and long range transport dominate aerosol concentrations as opposed to the local primary sources. For example, in Dublin, contribution from oxygenated organic aerosol (OOA) is as large as 85% (Figure 1) while in Galway, west coast of Ireland, combined secondary organic and inorganic aerosol accounts for ~90% of the total summer PM1. Concentration-Weighted Trajectory analysis indicates the secondary aerosol being mainly associated with regional background and easterly long-range transport from the UK and/or France.
Hence, source apportionment is crucial to inform efficient air policy implementation that targets biggest air pollution culprits.

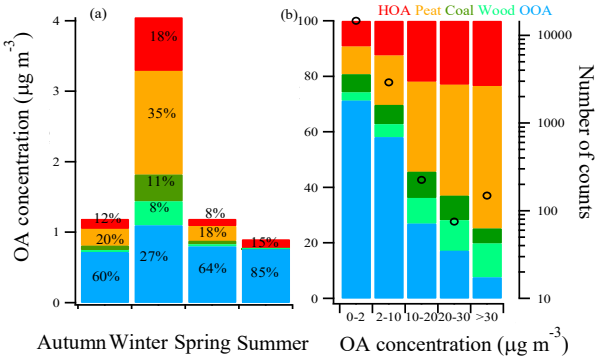

Figure 1. Organic aerosol source apportionment in Dublin: (a) average contribution (%) of sources (i.e. HOA, peat, coal, wood, and OOA) to total OA mass during autumn, winter, spring, and summer; and (b) factor fraction (%) of total OA mass as a function of OA mass category (left axis) and number of events (right axis).

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