Major influence of secondary organic aerosols on black carbon absorption enhancement in the region of Paris, France

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Introduction

Atmospheric black carbon (BC) and light-absorbing organic aerosol (also referred as brown carbon, BrC) have strong effects on the Earth's climate by absorbing direct solar radiation. To better characterize and quantify these effects, it is still needed to improve the understanding of specific underlying mechanisms such as the influence of primary emissions and secondary processes on absorption properties over long-term periods. We report here results of a three-year continuous field observations of both optical and chemical aerosol properties from March 2014 to March 2017 at a suburban background station (SIRTA) in the Paris region (France).

Methods

Submicron non-refractory aerosol species were measured in near real-time using an aerodyne aerosol chemical speciation monitor and were apportioned using Positive Matrix Factorization (PMF) analysis to identify and quantified major organic aerosol (OA) sources. Light absorption properties of BC and BrC were determined by direct measurements using a 7-wavelength aethalometer equipped with the dual spot technology. Co-located 24-hy filter-based analyses were performed by thermo-optical technique to quantify the mass concentration of elemental carbon (EC) in $PM_{2.5}$. Absorption enhancement (E_{abs}) of BC-containing particles was obtained using mass absorption coefficient (MAC) ratios calculated between observed (= b_{abs} / [EC]) and expected values for uncoated BC.

Results

Results showed important BrC contribution to the total absorption in the near UV during te winter season, that could be attributed to residential wood burning activities. Even more interestingly, the observed E_{abs} significantly increased with the mass ratio of secondary aerosols to EC, suggesting a strong influence of this secondary components on BC absorption enhancement. This was further associated with the production of highly oxidized secondary organic aerosols (SOA), especially at summertime (Figure 1). These findings infer that considering the yearly cycle of photochemical SOA production should help better assessing seasonal influences of BC global warming. They also suggest that efficient strategies for the reduction of SOA burden in the atmosphere - including abatement of volatile organic compounds emissions - could significantly weaken the BC radiative forcing, at least over the Paris area.

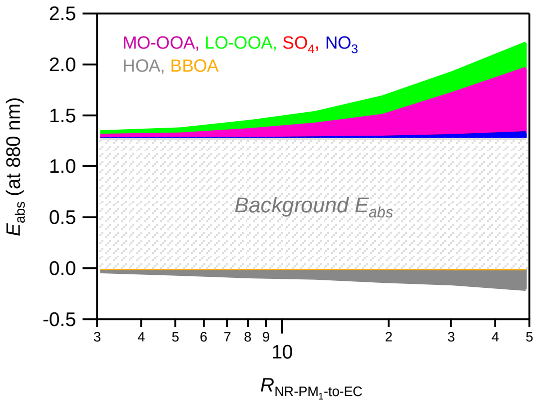

Figure 1. Contributions of submicron components to BC absorption enhancement.

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