Real-time chemical characterization of submicron particles in M'Bour, Senegal during the 2015 dry season

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Numerous field campaigns have been conducted all around the world to better characterize long-term chemical composition of submicron aerosols (PM_1) with high-time resolution instruments. Yet, to the best of our knowledge, only one has been carried out on the African continent, in South Africa (Tiitta et al., 2014). In this work, we offer the first insight of long-term chemical characterization of PM_1 in West Africa.

Our instrumentation was implemented at the AERONET station of M'Bour (Senegal) during the SHADOW-2 (SaHAran Dust Over West Africa) campaign which was divided in two intensive observations periods: IOP-1 (Mar. - Jun. 2015) and IOP-2 (Dec. - Jan. 2016). Results were obtained using an Aerosol Chemical Speciation Monitor for Non-Refractory (NR) PM_1, a 7-wavelength Aethalometer (AE33) for Black carbon (BC) and Iron (Fe), and a tapered element oscillating microbalance (TEOM-FDMS) for total PM_1.

Data acquired during IOP-1 show high variability both in terms of chemical composition and mass concentrations. The first half of IOP-1 was marked by intense but short NR-PM_1 pollution events, sea breeze phenomena and longer Saharan desert dust episodes. During the second half, the sampling site was mainly under marine influence. For days under continental (CTL) and sea breeze (SB) influences, organic (OA) species dominated (40%), whereas sulfate (SO_4) was predominant (40%) for days under marine influence (Fig.1a). On average, ~ 2/3 of total PM_1 was explained by NR and BC concentrations, leaving 1/3 for dust and sea salt which was found negligible in this size fraction.

The IOP-1 OA fraction was furthermore investigated with Positive Matrix Factorization (PMF). The solution led to two primary emission sources with 21% of OA corresponding to Cooking-like (COA) and 23% to Hydrocarbon-like (HOA) OA. Two types of secondary oxygenated OA (OOA) were also identified with 42% of More Oxidized (MO) and 8% of Less Oxidized (LO) OOA. HOA and COA are locally emitted by traffic and residential cooking activities (including traditional fish-smoking), respectively, as confirmed by their CTL and SB daily profiles (Fig. 1c). The MO-OOA high concentration observed regardless of day type suggest a rather background regional source. Its high oxidation level can be explained by primary OA species that undergo intense photochemistry due to high solar radiation and temperatures encountered in the region. The LO-OOA mass spectrum, containing a strong m/z 36 (chloride fragment) peak also added as a PMF input, combined with wind direction suggests a newly observed specific source, due to open waste burning areas located in the surroundings.
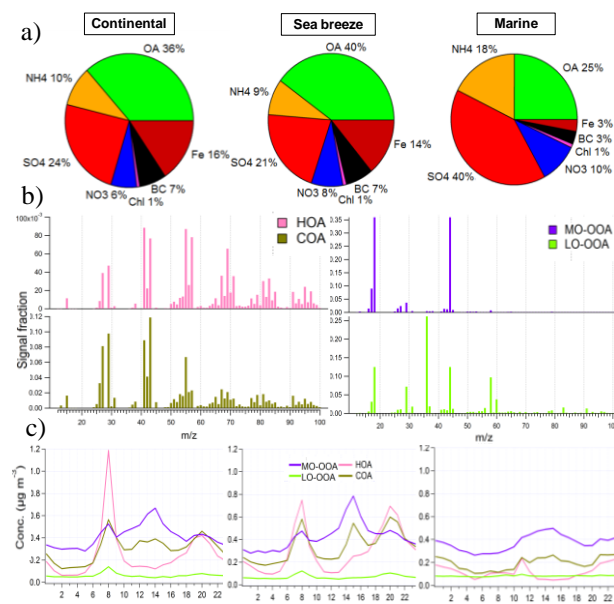

Fig. 1. (a) Averaged pie charts for IOP-1, (b) PMF 4-factor solution mass spectra and (c) corresponding daily cycles for CTL, SB and marine days (left to right).

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