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One year online chemical speciation of submicron particulate matter (PM1) sampled at a French industrial and coastal site

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The harbor of Dunkirk (Northern France) is surrounded by different industrial plants (metallurgy, petrochemistry, food processing, power plant, etc.), which emit gaseous and particulate pollutants such as Volatile Organic Compounds (VOCs), oxides of nitrogen (NO_x) and sulfur (SO_2), and submicron particles (PM_1). These emissions are poorly characterized and their impact on neighboring urban areas has yet to be assessed. Studies are particularly needed in this type of complex environments to get a better understanding of PM_1 sources, especially from the industrial sector, their temporal variability, and their transformation.

Several instruments, capable of real-time measurements (temporal resolution $\leq$ 30 min), were deployed at a site located downwind from the industrial area of Dunkirk for a one-year duration (July 2013-September 2014). An Aerosol Chemical Speciation Monitor (ACSM) and an Aethalometer monitored the main chemical species in the non-refractory submicron particles and black carbon, respectively. Concomitant measurements of trace gases and wind speed and direction were also performed. This dataset was analyzed considering four wind sectors, characteristics of marine, industrial, industrial-urban, and urban influences, and the different seasons. We will present a descriptive analysis of PM_1, showing strong variations of ambient concentrations, as well as evidences of SO_2 to SO_4 gas-particle conversion when industrial plumes reached the monitoring site. The organic fraction measured by ACSM (37% of the total mass on average) was analyzed using a source-receptor model based on Positive Matrix Factorization (PMF) to identify chemical signatures of main emission sources and to quantify the contribution of each source to the PM_1 budget given the wind sector. Four main factors were identified: hydrocarbon organic aerosol (HOA), oxygenated organic aerosol (OOA), biomass burning organic aerosol (BBOA) and cooking-like organic aerosol (COA). Overall, the total PM_1 mass loading was dominated by secondary inorganic species and OOA. The seasonal variations of different identified factors will be discussed as well as the influence of ship emissions.