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Gaseous composition measured by a chemical ionization mass spectrometer in fresh and aged ship plumes

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The port of Gothenburg is the largest port of the Nordic countries with numerous ships calling the port daily. The ship exhausts contain numerous pollutants including gases such as SO_2 and NO_x as well as particulate matter and soot. The exhaust also contains numerous organic compounds, a large fraction of which are unidentified. These organics are oxidized in the atmosphere producing more oxygenated and potentially less volatile compounds that may contribute to the secondary organic aerosol (SOA). This work focuses on the characterization of fresh gaseous species present in the exhaust plumes of the passing ships and also on their photochemical aging.

Between 26 September and 12 November 2014 measurements were conducted at a sampling site located on a small peninsula at the entrance of Gothenburg's port. The campaign was divided in two periods. During the first period, the fresh plumes of the passing ships were measured through a main inlet. During the second period, the sample passed through the same inlet and was then introduced into a Potential Aerosol Mass (PAM) reactor. The PAM reactor uses UV lamps and high concentrations of oxidants (OH radicals and O_3) to oxidize the organic species present in the plumes. The oxidation that takes place within the reactor can be equivalent to up to one week of atmospheric oxidation. Preliminary tests showed that the oxidation employed in the current camping corresponded to 3.4 days in the atmosphere.

A Time-of-Flight Chemical Ionization Mass Spectrometer (ToF-CIMS) was employed to monitor the concentration of different organic species present in the fresh and aged plumes. Water (positive) and iodide (negative) ionization methods were employed were water was primarily used for fresh plumes (large fraction of non-polar compounds) while iodide was used for the aged plumes (primarily oxidised products). The H_2O, O_3 and SO_2 concentrations inside the PAM chamber were monitored, and an organic tracer for OH exposure determination was also continuously measured. The dominant species concentrations of both fresh and aged ship plumes are presented and their emission factors are estimated from concurrent CO_2 measurements.