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Influence of anthropogenic emissions from shipping and industry on Cl-radical generation around the Arabian Peninsula during AQABA

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We present shipborne measurements of nitryl chloride ($ClNO_2$), hydrogen chloride (HCl) and sulphur dioxide (SO_2) around the Arabian Peninsula performed with a Chemical Ionisation Quadrupole Mass Spectrometer (CI-QMS) with electrical discharge ion source. The unique data set covering the Mediterranean Sea, Red Sea, Arabian Sea and the Arabian Gulf was collected during the AQABA (Air Quality and climate change in the Arabian BAsin) ship campaign in summer 2017. We study the importance of $ClNO_2$ formation via dinitrogen pentoxide (N_2O_5) uptake to sea-salt aerosols for Cl-radical generation in a marine boundary layer that is strongly influenced by emissions from shipping and oil industry. We derive a region-dependent $ClNO_2$ production efficiency and investigate the influence of particulate chloride abundance, the reactivity of NO_3 towards volatile organic compounds (VOCs) and the N_2O_5 uptake coefficient on this parameter. The relative contribution to Cl-atom formation via $ClNO_2$ photolysis and OH-induced HCl oxidation is quantified, whereby the HCl is suggested to be mainly released from aerosols via acid displacement through HNO_3 and H_2SO_4.