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Mass closure study of submicron particles and their light scattering properties in the Mediterranean and Middle East regions during the AQABA shipborne campaign.

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Time-resolved, on-line chemical and optical properties of atmospheric submicron particles were monitored during a 2-month (1st July - 1st September 2017) intensive ship campaign, named AQABA (Air Quality and climate change in the Arabian BAsin) that consisted of a round trip from southern France (Toulon) to Kuwait crossing the Mediterranean Sea, Red Sea, Indian Ocean and Arabian Gulf. The project was led by the Max Planck Institute for Chemistry with the aim to investigate the properties of ambient gases and aerosol around the Arabian Peninsula.

The detailed chemical composition of submicron aerosols, which included both refractory and non-refractory components, indicated the highest loadings over the Arabian Gulf, dominated by ammonium sulfate. The sum of the measured chemical components was in good agreement (R2=0.84) with reconstructed mass derived from co-located measurements of size-resolved aerosol number concentration. It is shown that in the Middle East region, refractory components, such as sea salt and/or dust particles, are present in the submicron range at significant concentration levels, being a requirement to achieve submicron aerosol mass closure.

The light scattering coefficient of submicron aerosols was reconstructed using three methods; semi-empirical equations based on composition alone, Mie calculations based on the combination of the ionic composition and organic mass and Mie calculations based on chemical components derived from an ion pairing scheme. The two latter methods also used aerosol size distribution measurements as input. The reconstructed light scattering coefficient was compared with that measured on-board using a polar nephelometer and discussed for each marine region crossed by the ship (Mediterranean Sea, Red Sea, Indian Ocean and Arabo-Persian Gulf).