

Abstract

Measurements of aerosol particle size distributions in the range 5 nm - 4 μm at 1.5 m above sea level were carried out on board a boat in German waters of the Baltic Sea. The measurements were aimed at characterizing aerosol particles from marine aerosol and from ship diesel engines and their dynamics, i.e. the aging of the exhaust plume in the marine boundary layer. The marine aerosol of PNC_{5-340} 1335-1939 cm^{-3} is characterized by Aitken, accumulation and coarse modes of CMD 20 and 41-55 nm and 123-159 nm and 1.6 μm , respectively. The ratio of the accumulation to the Aitken mode increases with increasing shipping density. Aerosol particles from diesel engines in exhaust plumes with an age of 2 - 60 s and at a distance of 150 - 600 m from the surveyed ships are characterized by PNC_{5-340} 1-4 $\cdot 10^5$ cm^{-3} and CMD 20 nm. The modal size distribution of supermicron particles of D_a 1 - 4 μm does not change in the exhaust plume, the total mass of supermicron particles increases only by 1 - 6% compared to the background. The dynamics of the size distributions of aerosol particle numbers is mainly due to the formation, i.e. expansion and dilution, of the plume. However, in the exhaust plume with an age of 6 - 16 s and at a distance of 50 - 150 m, a faster decrease was observed for PNC_{20} due to the transformation of the exhaust plume, i.e. possible coagulation of nanoparticles. Self-coagulation can be neglected as indicated by the constant CMD during ship tracking. Coagulation with aerosol particles of the accumulation or coarse mode is very slow. An explanation could be the coagulation of 20 nm particles with microdroplets of sea spray over the ship's trail generated by disturbing of seawater due to the movement of the ship's hull and in particular the rotation of the ship's propellers, i.e. the formation of cavitation bubbles. Verification of this assumption would be confirmed in further measurements by chemical analysis of size-segregated aerosol particles and measurement of droplet size distribution.

Keywords: ships, ship track, boats, diesel engine of ships, aerosol size distribution