

# Characterizing the particle composition and cloud condensation nuclei from shipping emission in Western Europe

Mr Chenjie Yu

University of Manchester

Chenjie Yu, Dominika Pasternak, James Lee, Mingxi Yang, Thomas Bell, Keith Bower, Huihui Wu, Dantong Liu, Chris Reed, Stéphane Bauguitte, Sam Cliff, Jamie Trembath, Hugh Coe and James D. Allan

Commercial shipping is considered as an important source of air pollution and Cloud Condensation Nuclei (CCN). This airborne measurement study presents the online characterization of particulate phase ship emissions in the region of Western European in 2019 prior to new international sulphur emission controls becoming enacted. More than forty ships from both Sulphur Emission Control Area (SECA) in the English Channel and the Open Sea (OS) are measured and compared. Ships within the SECA emitted much less sulphate (SO<sub>4</sub>) compared with the ships at OS. The size distribution results showed that when shifted to the lower apparent Fuel Sulphur Content (FSC) at similar engine loads, the peak of the ship emitted particle number size distribution shifted from around 60 - 80nm to below 40nm. The emission factors (EFs) of sulphate are predicted to decrease by around 93% in response to the new International Maritime Organization (IMO) 2020 global sulphur emission cap. The EFs of refractory Black Carbon (rBC) and organic compounds (Org) do not appear to be directly affected by the lower sulphur contents. The total number concentration for Condensation Nuclei (CN) >2.5nm and >0.1µm are predicted to be reduced by 65% and 55% respectively. Measured plume evolution results indicate that the S(IV) to S(VI) conversion rate was around 23.4%/hour at the beginning of plume evolution, and the CCN and CN >2.5nm ratio increased with plume age primarily due to condensation and coagulation. We estimate that the new sulphur emission regulation will lead to a reduction of more than 80% in CCN from ship emissions. The ship emitted EFs results presented here will also inform emission inventories, policymaking, climate and human health studies.