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Effects of Shipping–originated Aerosols on Cloud Physical Properties Over Marine Areas Near East China

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Shipping emissions have received increasing attention due to their influence on regional climate and air quality at ports and over coastal areas around the world. In the context of climatology, the effect of shipping-originated aerosols (aerosol optical depth as a proxy, AODship) on clouds over marine areas near East China were examined based on multi-satellite datasets. AODship is on average approximately 0.17, 0.20, 0.15 and 0.13 in the four seasons, making up 23%, 30%, 36% and 25% of the total AOD, respectively. Over remote sea areas, AODship is generally higher in spring and summer and lower in autumn. Statistical analysis showed that AODship has significant relationships with cloud parameters, such as cloud fraction (CF), cloud optical thickness (COT) and cloud effective radius (CER) in liquid phase. In particular, there is a significant positive correlation between CER and AODship in winter but a weakly negative correlation in summer over the northern East China Sea and a positive correlation in spring and summer over the Yellow Sea. COT and CF decrease with increasing AODship over coastal areas in all four seasons. The relationships between AODship and cloud properties are more significant for well–mixed aerosol–cloud layers (correlation coefficient, $r > 0.3$) than separated layers, indicating that the shipping-originated aerosols pinched into the cloud body can directly affect the microphysical properties of cloud droplets in cloud formation processes. The water vapor content and upward air motion are key thermodynamic conditions within the low atmospheric layers under the cloud bottom that play an important role in cloud formation and development. The results provide some new insights into the influence of shipping emissions on clouds over Asian marine areas.