Characterization of aerosol optical characteristics, vertical distribution and radiative forcing of ambient aerosols over the Yangtze River Delta during 2013–2015

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As the central part of eastern China, the Yangtze River Delta (YRD) region, with its rapid economic growth and industrial expansion, has experienced severe air quality issues. In this study, the monthly variation and interaction between aerosol optical properties, aerosol direct radiative forcing (ADRF) and aerosol vertical structure during 2013–2015 over the YRD were investigated using ground-based observations from a Micro Pulse Lidar and a CE-318 sun-photometer. Combining satellite products from MODIS and CALIPSO, and reanalysis wind fields, enhanced haze pollution events affected by different types of aerosol over the YRD region were analyzed through vertical structures, spatial distributions, backward trajectories, and the potential source contribution function (PSCF) model. The results reveal that a shallower PBL coincides with higher scattering extinction at low altitude, resulting in less heating to the atmosphere and radiative forcing to the surface, which in turn further depresses the PBL. Like in June and September, the hygroscopic growth facilitated by high relative humidity leads to high scattering extinction coefficient and relatively low PBL. In months with a deeper PBL, the extinction coefficient decreases rapidly with altitude, showing stronger atmospheric heating effects and ADRF to the surface by absorptive particles, facilitating the turbulence and vertical diffusion of aerosol particles, which further reduces the extinction and raises the PBL, like July and August with high single scatter albedo (SSA). The PBL height is greater (ranging from 1.23 to 1.84 km) and more variable in the warmer months of March to August, due to the stronger diurnal cycle and exchange of heat. Not only polluted by the local emissions, northern fine-mode pollutants are brought to the YRD at a height of 1.5 km. The SSA increases, creating a feedback to the cooling effect. Originated from the deserts in Xinjiang and Inner Mongolia, long-range transported dust masses are seen at heights of about 2 km over the YRD region with an $SSA_{440\ nm}$ below 0.84, which heat air and raise the PBL, accelerating the diffusion of dust particles. Regional transport from biomass-burning spots to the south of the

YRD region bring absorptive particles at a height below 1.5 km, resulting in an $SSA_{440\ nm}$ below 0.89. During the winter, the accumulation of the local emission layer is facilitated by stable weather conditions, staying within the PBL even below 0.5 km [1,2].

References

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