ABSTRACT

Fine particulate matter ($PM_{2.5}$) concentrations in Metro Manila, Philippines have consistently exceeded the guideline values set by the World Health Organization (WHO). Although there has been much progress in understanding the components and sources of $PM_{2.5}$, limited research has been done on the influence of meteorological factors. In particular, the influence of the planetary boundary layer height (PBLH) on $PM_{2.5}$ concentration has not been studied due to inadequate observations. From January 2019 – June 2020, measurements from a High Spectral Resolution Lidar (HSRL) filled this gap and allowed for PBLH estimation and aerosol typing. This study investigates the roles of PBLH and regional and local wind circulations on the temporal evolution of aerosol pollution. Results show that daytime and nighttime PBLH variability is associated with solar heating and radiative cooling, respectively. Cloud-free conditions during the dry season yield a higher planetary boundary layer (PBL) growth rate than during the wet season when lower daytime and elevated nighttime PBLH are observed. Lower $PM_{2.5}$ levels are generally observed during daytime when PBLH is at its maximum. However, the PBLH has a significant inverse correlation with $PM_{2.5}$ only in the months of December-January-February. This study found that horizontal directional wind shear between synoptic and mesoscale circulations confounds the $PM_{2.5}$ – PBLH relationship by creating stagnant conditions conducive to aerosol accumulation. The lower 20% of $PM_{2.5}$ concentrations occur during the prevalence of strong monsoon winds. On the other hand, the upper 80% are found during the occurrence of compound mesoscale winds (i.e., sea/land/lake/valley/mountain breezes and channeling monsoon winds). In addition, mountain breeze is found to be associated with lifting of aerosols, resulting in multi-layering within the PBL. The findings in the present study emphasize the important role of complex topography and mesoscale scale winds arising from the unique land-water distribution of an area on aerosol pollution variability.