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Direct measurement of new particle formation around the top of planetary boundary layer in urban of China

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New particle formation (NPF) is one of the main sources of aerosols and play an important role in global climate change by contributing up to two thirds of the atmospheric cloud condensation nuclei. There has been numerous studies on characteristic and mechanism of near-surface NPF. However , how the NPF around the top of planetary boundary layer (PBL) remains unclear because of the limitations of measurements. In this study, according to the weather and air quality forecast, we design an experiment to directly observe the NPF around the top of PBL in the Yangtze River Delta (YRD) of China by using a tethered airship. Despite not being observed at three ground sites in YRD, NPF event occurred above the PBL with the growth rate of 3.8 nm/h. As the PBL evolved, NPF was suppressed by high concentration of pre-existing aerosol within the PBL . High ozone concentrations, low pre-existing aerosols and NO_x concentration and enough precursor vapors such as SO_2 and volatile organic compounds cause the occurrence of NPF. Air masses from cities clustered suppressed the NPF. MALTE-BOX model can simulate the NPF event. Sulfuric acid was found to play important roles in nucleation and growth of aerosol above the PBL, which was consistent with the observations that the mass fraction of sulfate in the PM2.5 was 30% above the PBL compared to the 11% within PBL. The simulations by WRF-Chem shows much higher sulfuric acid concentration in wide range of area above PBL than at ground. Therefore, only the observations at ground cannot capture the roles of NPF in aerosol budgets globally. We highlight the need of observations around or above the PBL and introduce the method of experiment design in this study.