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# The importance of coagulation scavenging to secondary new particle formation in polluted urban atmospheric environments

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Frequent new particle formation events contribute significantly to particle number concentrations in polluted urban atmospheric environments. The characteristics and mechanisms of new particle formation have been studied in relatively clean atmospheric environments in the past several decades, yet they are not well-understood in polluted atmospheric environments. For characterizing new particle formation in polluted atmospheric environments, we propose a population balance formula for better estimating the formation rate of new particles, which is a key parameter quantifying the intensity of new particle formation. Compared to the formulae used in previous studies, this new balance formula mainly improves the estimation of particle scavenging and formation due to coagulation. According to this new formula, net particle loss due to coagulation scavenging is the major contributor to the estimated new particle formation rate in polluted atmospheric environments, whereas the measured temporal evolution of particle number concentration is the major contribution in relatively clean atmospheric environments. This is because of the comparatively higher concentrations of both pre-existing aerosol and newly formed particles in polluted atmospheric environments than those in relatively clean atmospheric environments. Accordingly, underestimating particle loss rate due to coagulation scavenging in polluted atmospheric environments will cause the underestimation of new particle formation rate. Another newly proposed formula for estimating the contribution of transport to the measured temporal evolution of particle size distribution indicates that the number concentration of newly formed particles in polluted atmospheric environments is only a small residue compared to accumulative coagulation scavenging and condensational growth. The survival probability of newly formed particles is determined by the ratio of coagulation loss rate to condensational growth rate. In the polluted atmosphere in urban Beijing, the concentrations of gaseous precursors for new particles determining condensational growth are relatively constant whereas the surface area concentration of pre-existing particles may vary significantly. As a result, coagulation scavenging is usually found to be the governing factor determining whether a new particle formation in urban Beijing occurs or not, which is different from the characteristics of new particle formation events previously reported in other atmospheric environments. The above results emphasize the importance of coagulation scavenging when studying new particle formation in polluted atmospheric environments.