

***AN IMPROVED CRITERION FOR NEW PARTICLE FORMATION  
IN DIVERSE ENVIRONMENTS***

Chongai Kuang, Brookhaven National Laboratory  
Ilona Riipinen, Carnegie Mellon University  
Sanna-Liisa Sihto and Markku Kulmala, University of Helsinki  
Alon McCormick and Peter McMurry, University of Minnesota

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**Environmental Sciences Department/Atmospheric Sciences Division  
Brookhaven National Laboratory  
P.O. Box, Upton, NY  
www.bnl.gov**

**ABSTRACT**

A dimensionless theory for new particle formation (NPF) was developed, using an aerosol population balance model incorporating recent developments in nucleation rates and measured particle growth rates. Based on this theoretical analysis, it was shown that a dimensionless parameter  $L_g$ , characterizing the ratio of the particle scavenging loss rate to the particle growth rate, exclusively determined whether or not NPF would occur on a particular day. This parameter determines the probability that a nucleated particle will grow to a detectable size before being lost by coagulation with the pre-existing aerosol. Cluster-cluster coagulation was shown to contribute negligibly to this survival probability under conditions pertinent to the atmosphere. Data acquired during intensive measurement campaigns in Tecamac (MILAGRO), Atlanta (ANARChE), Boulder, and Hyttiälä (QUEST II, QUEST IV, and EUCAARI) were used to test the validity of  $L_g$  as an NPF criterion. Measurements included aerosol size distributions down to 3 nm and gas-phase sulfuric acid concentrations. The model was applied to 77 NPF events and 19 non-events (characterized by growth of pre-existing aerosol without NPF) measured in diverse environments with broad ranges in sulfuric acid concentrations, ultrafine number concentrations, aerosol surface areas, and particle growth rates (nearly two orders of magnitude). Across this diverse data set, a nominal value of  $L_g = 0.7$  was found to determine the boundary for the occurrence of NPF, with NPF occurring when  $L_g < 0.7$  and being suppressed when  $L_g > 0.7$ . Moreover, nearly 45% of measured  $L_g$  values associated with NPF fell in the relatively narrow range of  $0.1 < L_g < 0.3$ .