

Research Highlight

On local to global scales, newly formed particles contribute significantly to the concentration of atmospheric particles. In general, particles influence climate by affecting the balance of atmospheric radiation, both directly through scattering and absorbing incoming solar radiation and indirectly through impacts on cloud properties and lifetimes. However, the process of particle formation has long puzzled scientists. Currently, researchers model particle formation based on the interactions of only sulfuric acid and water, key components of these particles, but theory and observations simply do not match. The current modeling approach also requires significant computational resources, which can be costly.

Now, researchers have proposed two conceptually new approaches that build on field measurements, laboratory experiments, and theoretical computations. Both approaches tackle the problem of modeling particle formation by looking at the process as a series of acid-base chemical reactions that now include interactions with amines and ammonia. By identifying key steps in the series, these approaches can quantitatively predict formation rates and concentrations of newly formed particles, while keeping the computational cost low enough to be suitable for inclusion in large-scale atmospheric models.

Particle formation plays an important role in predicting aerosol impacts on climate. Realistic assessment of these impacts in large-scale atmospheric simulations depends heavily on particle formation models that not only accurately predict formation rates but require less use of costly computing resources. These two new models provide a framework to better understand formation and incorporate the complex role of amines how these particles and ammonia, which has now been shown to be essential for new particle formation.

Scientists developed the two approaches from different vantage points. One approach involved experiments in a laboratory flow tube in which gaseous chemicals and water vapor interact to form particles. Scientists then measured how the particles were distributed in the vapor using a mobility scanner that determined particle sizes. In the other approach, researchers combined real-world observations from intensive field measurement campaigns in Atlanta and Mexico City with laboratory experiments. Using new instruments developed for this effort, scientists measured a number of previously inaccessible quantities, including the concentrations of reacting vapors and of particles down to sub-nanometer sizes. In both cases, researchers found that by using the new data and identifying the key series of steps needed to form particles, they were able to capture the necessary complexity of particle formation in a simple model.

Reference(s)

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Dawson ML, ME Varner, V Perraud, MJ Ezell, RB Gerbery, and BJ Finlayson-Pitts. 2012. "Simplified mechanism for new particle formation from methanesulfonic acid, amines, and water via experiments and ab initio calculations." *Proceedings of the National Academy of Sciences*, 109(46), doi:10.1073/pnas.1211878109.

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Working Group(s)

Aerosol Life Cycle



The flow of particles: Researchers used complex equipment such as this flow tube (left) and outdoor measurement facilities (right) to determine the series of steps needed to form particles in the atmosphere, resulting in more accurate models.