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GROWTH RATES OF FRESHLY NUCLEATED PARTICLES

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ABSTRACT

The birth of new particles in the atmosphere is a significant process because both nucleation and growth rates are much higher than expected based on early naïve models. Our research aims to elucidate the mechanisms responsible for these high rates. This poster focuses on work we've done over the past year that will contribute to our understanding of fast growth rates of freshly nucleated particles. This work includes the development of improved methods to measure size distributions of particles down to 1 nm and methods to use these data to quantify size-dependent growth rates down to 1 nm. In late 2010 and early 2011, McMurry's group hosted a workshop on nanoparticle detection (with new condensation particle counters [CPCs]) that can detect particles as small as 1 nm. Instruments from the University of Minnesota, Brookhaven National Laboratory, TSI Inc., and the University of Helsinki were evaluated in this study. The responses of instruments to monomobile particles consisting of sodium chloride, sucrose, silver, tungsten, polyethylene glycol, proteins, and molecular ions were evaluated. Some results from these measurements will be presented. Particles as small as 1.1 nm in mobility diameter (0.8 nm in geometric size) can now be detected with CPCs, but detection efficiencies are sensitive to the chemical composition of both the particles and the condensing vapor. The use of size distributions to infer growth rates of freshly nucleated atmospheric particles as small as 1 nm will also be illustrated. We find that at 1 nm, most growth is due to the condensation of sulfuric acid vapor. However, growth rates increase linearly with diameter above 1 nm, and this increase is due to the uptake of vapors other than sulfuric acid. We have not yet identified those vapors with certainty. TDCIMS measurements by Dr. James Smith have shown that organic salts account for 20%–50% of the particle mass for 10-nm particles, and we hypothesize that those compounds may also contribute to growth of smaller particles as well. Furthermore, efforts are ongoing to identify other constituents that contribute to growth and to explain the size-dependent growth mechanisms.