ULTRAFINE PARTICLE EVENTS

Scoring — 1 point for each question.

In answering the following questions, please refer to the three figures, reproduced from the indicated references.

(a) Referring to Figure 1, briefly describe the evident processes that cause the depicted episode to be labeled an "ultrafine particle event."

(b) Figure 1 contains an apparent error. Identify and correct the error.

(c) Figure 2 shows part of the instrumentation system used to collect monitoring data such as depicted in Figure 1. Explain briefly the key physical and chemical processes on which this instrument works.

(d) Instruments such as that depicted in Figure 2 have a lower limit on the particle size that they can detect. The minimum size is typically in the range 3-20 nm. Name and briefly describe the key underlying physical phenomenon that establishes the lower particle size limit.

(e) A second measurement device used in such studies is referred to as a nano-DMA, where DMA stands for "differential mobility analyzer." Explain briefly the underlying mechanisms that a DMA uses to sort particles according to size.

(f) Figure 3 depicts the results of one-year's monitoring data collected in Atlanta, GA. It shows a scatter plot of simultaneous determinations of particle volume concentration (particle volume per unit air volume) and particle number concentration, in both cases considering particles in the size range 3 nm - 2 μm. In terms of the underlying physical or chemical processes, explain why a poor correlation might be expected.

(g) Why is the lack of a correlation in Figure 3 significant with respect to air pollution policy?

(h) One mechanism that could conceivably account for ultrafine particle events is homogeneous homomolecular nucleation. Yet, this is not believed to be an important process in the atmosphere. Explain why.

(i) A second important mechanism that could contribute to ultrafine particle events is homogeneous binary nucleation. Name two chemical species that are likely candidates for such atmospheric homogeneous binary nucleation.

(j) State two substantial reasons why ultrafine particles may trigger substantially different health responses than accumulation-mode particles, even if the chemical constituents are the same.

References

M Kulmala, H Vehkamäki, T Petäjä, M Dal Maso, A Lauri, V-M Kerminen, W Bermili, PH McMurry, Formation and growth rates of ultrafine atmospheric particles: A review of observations, *Journal of Aerosol Science* **35**, 143-176, 2004.

PH McMurry, The history of condensation nucleus counters, *Aerosol Science & Technology* **33**, 297-322, 2000.

KS Woo, DR Chen, DYH Pui, PH McMurry, Measurement of Atlanta aerosol size distributions: Observations of ultrafine particle events, *Aerosol Science & Technology* **34**, 75-87, 2001.

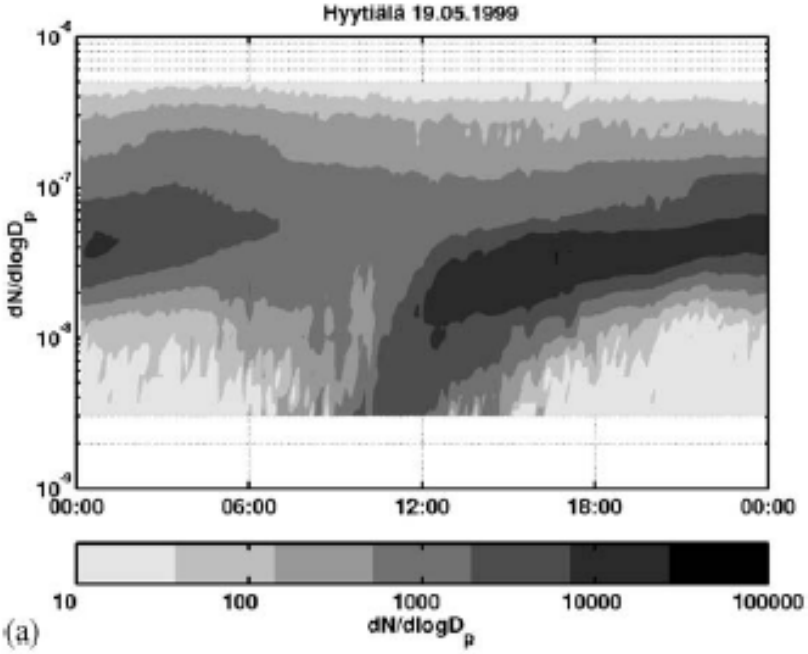

Figure 1. Typical particle formation event in Hyytiälä boreal forest site on 13th March 1996: particle size distribution data as a surface plot. (Kulmala et al., 2004).

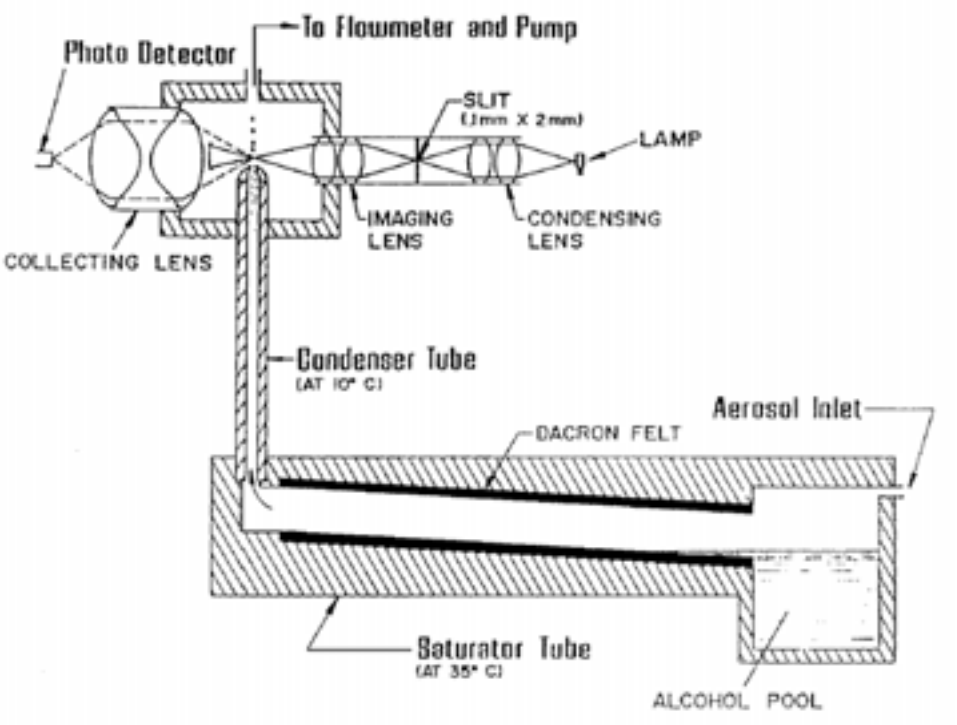

Figure 2. The TSI 3020 continuous flow, single-particle counting condensation nucleus counter (McMurry, 2000).

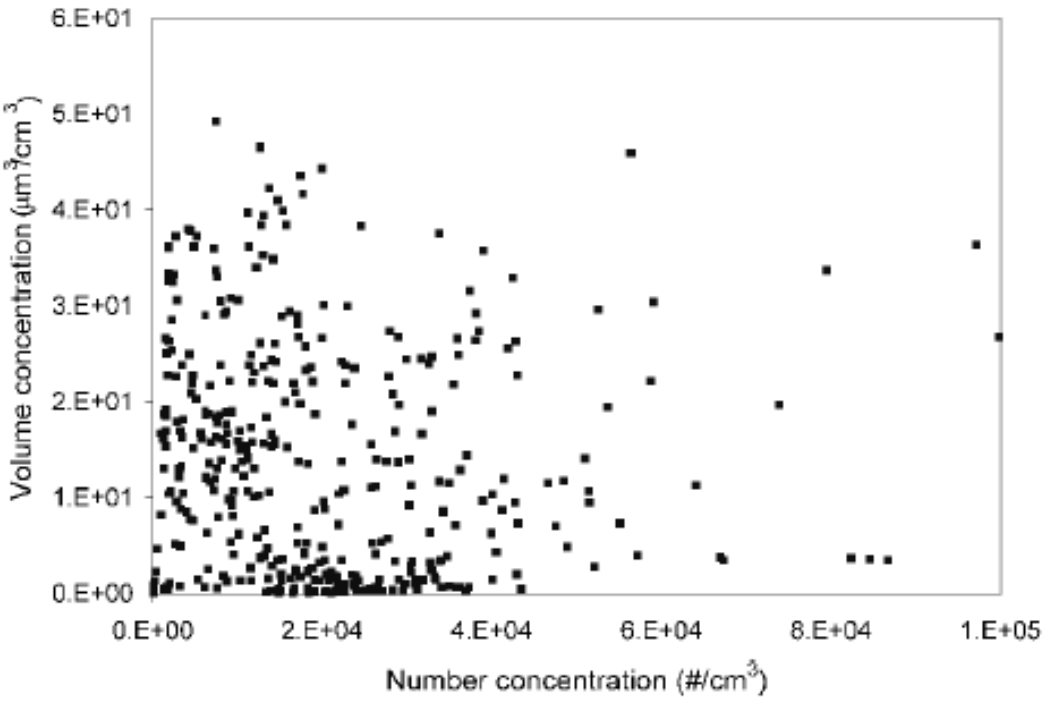

Figure 3. Correlation between number and volume concentration (Woo et al., 2001).