



Evidence For New Sulfate Particle Formation In The Remote Troposphere Involving Biogenic Trace Gas Species

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Findings from earlier field studies (Weber et al., 1995; Weber et al., 1997) showed that rates of new particle formation in the remote troposphere can be significantly higher than those predicted by classical heteromolecular sulfuric acid - water ($\text{H}_2\text{SO}_4\text{-H}_2\text{O}$) nucleation theory (Jaeger-Voirol and Mirabel, 1989). We have speculated that higher rates may be due to the participation of ammonia (NH_3) through a ternary mechanism involving $\text{H}_2\text{SO}_4\text{-NH}_3\text{-H}_2\text{O}$ (Weber et al., 1996). Airborne measurements made in the vicinity of Macquarie Island during the first Aerosol Characterization Experiment (ACE 1) support the hypothesis that participation of additional species can result in particle formation rates that significantly exceed rates for $\text{H}_2\text{SO}_4\text{-H}_2\text{O}$ nucleation (Weber et al., 1998a).

ACE 1 airborne measurements pertinent to studies of new particle formation included various meteorological parameters, gas phase H_2SO_4 and H_2O , and nanoparticle size distributions (~3 to 10 nm diameter). Nanoparticle concentrations were determined from the photo detector pulse heights of an Ultrafine Condensation Particle Counter (Weber et al., 1998b).

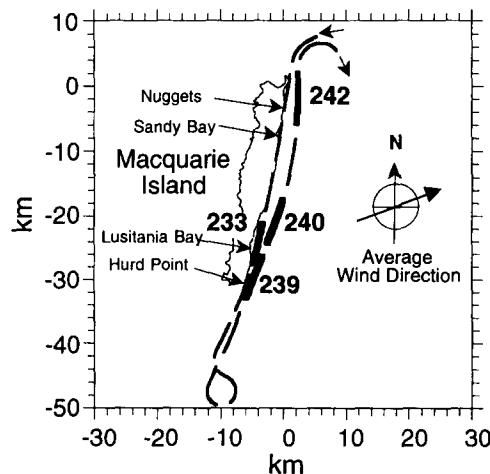


Figure 1: Aircraft measurements off the lee coast of Macquarie Island. Bands show aircraft trajectories during the one minute sample interval to measure nanoparticle spectra. Locations of four of the large penguin rookeries on Macquarie Island are identified by name. Thick bands, identified by sample number, are the only measurements where evidence of nucleation was observed. The corresponding nanoparticle distributions are shown in Figure 2.

Off the lee coast of Macquarie Island, measured nanoparticle size distributions showed clear evidence of nucleation exclusively downwind of large penguin rookeries (Figures 1 and 2), locations where NH_3 concentrations are expected to be high (Lindeboom, 1984). Of the measurements downwind of the rookeries, highest nanoparticle concentrations (e.g., sample number 240 in Figure 2) were observed in regions of highest H_2SO_4 concentrations, suggesting that H_2SO_4 also participated in particle formation. However, calculations show that in these regions nucleation of H_2SO_4 and H_2O would not occur.

This paper will present the Macquarie Island measurements and explore mechanisms of other nucleation events observed in the remote troposphere by comparing them to the Macquarie Island nucleation events and predictions of H_2SO_4 - H_2O nucleation.

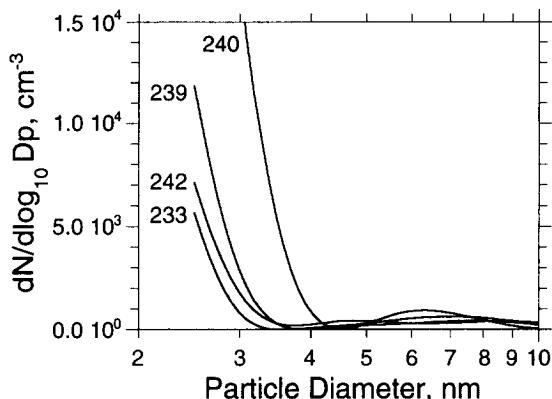


Figure 2: Nanoparticle size distributions recorded immediately downwind of penguin rookeries during ACE 1.

References

- Jaeger-Voirol, A. and P. Mirabel (1989). Heteromolecular nucleation in the sulfuric acid-water system, *Atmos. Envir.*, **23** 2053-2057.
- Lindeboom, H. J. (1984). The nitrogen pathway in a penguin rookery, *Ecology*, **65** 269-277.
- Weber, R. J., P. H. McMurry, F. L. Eisele and D. J. Tanner (1995). Measurement of expected nucleation precursor species and 3 to 500 nm diameter particles at Mauna Loa Observatory, Hawaii, *J. Atmos. Sci.*, **52** 2242-2257.
- Weber, R. J., J. J. Marti, P. H. McMurry, F. L. Eisele, D. J. Tanner and A. Jefferson (1996). Measured atmospheric new particle formation rates: Implications for nucleation mechanisms, *Chem. Eng. Comm.*, **151** 53-64.
- Weber, R. J., J. J. Marti, P. H. McMurry, F. L. Eisele, D. J. Tanner and A. Jefferson (1997). Measurements of new particle formation and ultrafine particle growth rates at a clean continental site, *J. Geophys. Res.*, **102** 4375-4385.
- Weber, R. J., P. H. McMurry, L. Mauldin, D. Tanner, F. Eisele, F. Brechtel, S. Kreidenweis, G. Kok, R. Schillawski and D. Baumgardner (1998a). A study of new particle formation and growth involving biogenic and trace gas species measured during ACE 1, *J. Geophys. Res.*, in press.
- Weber, R. J., M. Stolzenburg, S. Pandis and P. H. McMurry (1998b). Inversion of UCNC pulse height distributions to obtain ultrafine (~3 to 10 nm) particle size distributions, *J. Aerosol Sci.*, in press.