

Helmholtz Virtual Institute VH-VI-233

Role of aerosol particles as condensation and ice nuclei in tropospheric clouds (VI-ACI: Virtual Institute on Aerosol-Cloud Interactions)

Report 2009 – Publications

Peer-reviewed papers:

- Amsler, P., O. Stetzer, M. Schnaiter, E. Hesse, S. Benz, O. Moehler, and U. Lohmann (2009), Ice crystal habits from cloud chamber studies obtained by in-line holographic microscopy related to depolarization measurements, *Applied Optics*, 48(30), 5811-5822.
- Bunz, H., S. Benz, I. Gensch, and M. Krämer (2008), MAID: a model to simulate UT/LS aerosols and ice clouds, *Environ. Res. Lett.*, 3.
- Burkhardt, U., and B. Kärcher (2009), Process-based parameterization of contrail cirrus in a global climate model, *J. Geophys. Res.*, 114.
- Burkhardt, U., B. Karcher, M. Ponater, K. Gierens, and A. Gettelman (2008), Contrail cirrus supporting areas in model and observations, *Geophysical Research Letters*, 35(16), -.
- Chen, J.-P., A. Hazra, and Z. Levin (2008), Parameterizing ice nucleation rates using contact angle and activation energy derived from laboratory data, *Atmospheric Chemistry and Physics*, 8, 7431-7449.
- Connolly, P. J., O. Mohler, P. R. Field, H. Saathoff, R. Burgess, T. Choularton, and M. Gallagher (2009), Studies of heterogeneous freezing by three different desert dust samples, *Atmospheric Chemistry and Physics*, 9(8), 2805-2824.
- Gensch, I. V., H. Bunz, D. G. Baumgardner, L. E. Christensen, D. W. Fahey, R. L. Herman, P. J. Popp, J. B. Smith, R. F. Troy, C. R. Webster, E. M. Weinstock, J. C. Wilson, T. Peter, and M. Kramer (2008), Supersaturations, microphysics and nitric acid partitioning in a cold cirrus cloud observed during CR-AVE 2006: an observation-modelling intercomparison study, *Environmental Research Letters*, 3(3), -.
- Gierens, K., and S. Bretl (2009), Analytical treatment of ice sublimation and test of sublimation parameterisations in two-moment ice microphysics models, *Atmos. Chem. Phys.*, 9, 7481-7490.
- Hendricks, J., A. Falb, C. J. Stubenrauch, and C. Emde (2010), A method for comparing properties of cirrus clouds in global climate models with those retrieved from IR sounder satellite observations, *submitted*.
- Hoose, C., U. Lohmann, R. Erdin, and I. Tegen (2008), The global influence of dust mineralogical composition on heterogeneous ice nucleation in mixed-phase clouds, *Environmental Research Letters*, 3(2), -.
- Jones, H. M., M. J. Flynn, P. J. DeMott, and O. Möhler (2010), Manchester Ice Nucleus Counter (MINC) measurements from the 2007 International workshop on Comparing Ice nucleation Measuring Systems (ICIS-2007), *Atmos. Chem. Phys. Discuss.*, 10, 19277–19307.
- Kanji, Z. A., P. J. DeMott, O. Möhler, and J. P. D. Abbatt (2010), Results from the University of Toronto continuous flow diffusion chamber (UT-CFDC) at the international workshop for comparing ice nucleation measuring systems (ICIS 2007), *Atmos. Chem. Phys. Discuss.*, 10, 20857–20886.
- Kärcher, B., and U. Burkhardt (2008), A Cirrus cloud scheme for general circulation models, *Q. J. R. Meteorol. Soc.*, 134(635), 1439-1461.

- Kärcher, B., and P. Spichtinger (Eds.) (2009), *Cloud-controlling Factors of Cirrus*, pp.235-268 in: *Clouds in the Perturbed Climate System: Their Relationship to Energy Balance, Atmospheric Dynamics, and Precipitation*, MIT Press, Cambridge, MA.
- Kärcher, B., O. Möhler, P. J. DeMott, S. Pechtl, and F. Yu (2007), Insights into the role of soot aerosols in cirrus cloud formation, *Atmos. Chem. Phys.*, *7*, 4203-4227.
- Koehler, K. A., S. M. Kreidenweis, P. J. DeMott, M. D. Petters, A. J. Prenni, and O. Möhler (2010), Investigations of the impact of natural dust aerosol on cold cloud formation, *Atmos. Chem. Phys. Discuss.*, *10*, 19343–19380.
- Krämer, M., C. Schiller, A. Afchine, I. Gensch, A. Mangold, N. Spelten, N. Sitnikov, S. Borrmann, M. deReus, and P. Spichtinger (2009), Ice Supersaturations and Cirrus Cloud Crystal Numbers, *Atmos. Chem. Phys.*, *9*, 3505-3522.
- Lang-Yona, N., Y. Rudich, T. F. Mentel, A. Buchholz, A. Kiendler-Scharr, E. Kleist, C. Spindler, R. Tillmann, and J. Wildt (2010), The chemical and microphysical properties of secondary organic aerosols from Holm Oak emissions, *Atmos. Chem. Phys. Discuss.*, *10*(2), 4753-4788.
- Lohmann, U., and C. Hoose (2009), Sensitivity studies of different aerosol indirect effects in mixed-phase clouds, *Atmos. Chem. Phys.*, *9*, 8917-8934.
- Möhler, O., S. Benz, H. Saathoff, M. Schnaiter, R. Wagner, J. Schneider, S. Walter, V. Ebert, and S. Wagner (2008), The effect of organic coating on the heterogeneous ice nucleation efficiency of mineral dust aerosols, *Environ. Res. Lett.*, *3*, 025007.
- Nicolet, M., O. Stetzer, F. Lüönd, O. Möhler, and U. Lohmann (2010), Single ice crystal measurements during nucleation experiments with the depolarization detector IODE, *Atmos. Chem. Phys.*, *10*, 313-325.
- Niedermeier, D., S. Hartmann, R. A. Shaw, D. Covert, T. F. Mentel, J. Schneider, L. Poulain, P. Reitz, C. Spindler, T. Clauss, A. Kiselev, E. Hallbauer, H. Wex, K. Mildenerger, and F. Stratmann (2010), Heterogeneous freezing of droplets with immersed mineral dust particles - measurements and parameterization, *Atmospheric Chemistry and Physics*, *10*, 3601-3614.
- Reitz, P., and J. Schneider (2010), Noise level determination by local cubic signal approximation: Calculation of Aerodyne Aerosol Mass Spectrometer detection limits, *Atmospheric Measurement Technology Discussions*, submitted.
- Sölch, I., and B. Kärcher (2010), A large eddy model for cirrus clouds with explicit aerosol and ice microphysics and Lagrangian ice particle tracking, *Q. J. R. Meteorol. Soc.*, submitted.
- Spichtinger, P., and K. M. Gierens (2009), Modelling of cirrus clouds - Part 1a: Model description and validation, *Atmospheric Chemistry and Physics*, *9*(2), 685-706.
- Spichtinger, P., and K. M. Gierens (2009), Modelling of cirrus clouds - Part 1b: Structuring cirrus clouds by dynamics, *Atmospheric Chemistry and Physics*, *9*(2), 707-719.
- Spichtinger, P., and K. Gierens (2009), Modelling Cirrus Clouds. Part 2: Competition of different nucleation mechanisms, *Atmos. Chem. Phys.*, *9*, 2319-2334.
- Spichtinger, P., and D. J. Cziczo (2010), Impact of heterogeneous ice nuclei on homogeneous freezing events in cirrus clouds, *J. Geophys. Res.*, *115*, D14208.
- Teller, A., and Z. Levin (2008), Factorial method as a tool for estimating the relative contribution to precipitation of cloud microphysical processes and environmental conditions: Method and application, *J. Geophys. Res.*, *113*, D02202, doi:02210.01029/02007JD008960.
- Unterstrasser, S., and K. Gierens (2010), Numerical simulations of contrail-to-cirrus transition -Part 1: An extensive parametric study, *Atmos. Chem. Phys.*, *10*, 2017-2036.

- Unterstrasser, S., and K. Gierens (2010), Numerical simulations of contrail-to-cirrus transition -Part 2: Impact of initial ice crystal number, radiation, stratification, secondary nucleation and layer depth, *Atmos. Chem. Phys.*, 10(2037-2051).
- Unterstrasser, S., K. Gierens, and P. Spichtinger (2008), The evolution of contrail microphysics in the vortex phase, *Meteorologische Zeitschrift*, 17(2), 145-156.
- Wagner, R., O. Moehler, H. Saathoff, M. Schnaiter, and T. Leisner (2010), High variability of the heterogeneous ice nucleation potential of oxalic acid dihydrate and sodium oxalate, *Atmos. Chem. Phys. Discuss.*, 10, 11513-11575.
- Welti, A., F. Lüönd, O. Stetzer, and U. Lohmann (2009), Influence of particle size on the ice nucleating ability of mineral dusts. *Atmos. Chem. Phys. Discuss.*, 9, 6929-6955, *Atmos. Chem. Phys. Discuss.*, 9, 6929-6955.
- Zhao, D. F., A. Buchholz, T. F. Mentel, K. P. Müller, J. Borchardt, A. Kiendler-Scharr, C. Spindler, R. Tillmann, A. Trimborn, T. Zhu, and A. Wahner (2010), Novel method of generation of Ca(HCO₃)₂ and CaCO₃ aerosols and first determination of hygroscopic and cloud condensation nuclei activation properties, 10(3), 8009-8049., *Atmos. Chem. Phys. Discuss.*, 10(3), 8009-8049.

Book Chapters

- Ulanowski Z. and M. Schnaiter (2010) UV and visible light scattering and absorption measurements on aerosols in the laboratory. In: *Fundamentals and Applications of Aerosol Spectroscopy*, J. P. Reid and R. Signorell (eds.) Taylor & Francis, London.

PhD Theses

- Aquila, V. (2009), Global model studies on the distribution and composition of potential atmospheric ice nuclei, LMU München.
- Hoose, C. (2008), Aerosol processing and its effect on mixed-phase clouds in a global climate model, Eidgenössisch-Technische Hochschule, Zurich.
- Sölch, I. (2009), Ein Euler-Lagrange'sches Zirruswolken-Modell mit expliziter Aerosol- und Eismikrophysik: Studien zur Aggregation von Eisparkeln, Ludwig-Maximilians-Universität, München.
- Unterstrasser, S. (2008), Numerische Simulationen von Kondensstreifen und deren Übergang zu Zirren, Ludwig-Maximilians-Universität, München.

Bachelor/Master/Diploma Theses

- Erdin, R. (2007), Anteile von Kaolinit, Illit und Smektit in Aerosolen: Vergleich von Messdaten und Modellwerten, Eidgenössisch-Technische Hochschule, Zürich.
- Falb, A. (2008), Evaluation des mikrophysikalischen ECHAM-Wolkenmoduls im Hinblick auf die Zirrusbewölkung, Ludwig-Maximilians-Universität, München.
- Hartmann, S. (2009), First Experimental and Theoretical Studies concerning heterogeneous Ice Nucleation at the Leipzig Aerosol Cloud Interaction Simulator, University of Leipzig., Universität Leipzig, Leipzig.
- Lauer, C. (2007), Setup and validation of a calibration-free extractive 1.4 µm laser hygrometer for the aerosol chamber AIDA, Ruprecht-Karls Universität, Heidelberg.
- Strathmann, L. (2009), Entwicklung und Charakterisierung eines kompakten Wolkenpektrometers, Diplomarbeit thesis, Hochschule Aachen.

Welti, A. (2008), Influence of particle size on the ice nucleating ability of mineral dusts, ETH Zurich.

Conference Contributions

Ardon, K., Levin, Z., Ganor, E., Klein, H. and Bingemer, H (2008), The effect of air pollution on ice nuclei concentration in Israel, The International Conference on Clouds and Precipitation (ICCP), 2008, July 7-11, Cancun, Mexico.

Ardon, K., Levin, Z., Ganor, E., Klein, H., Bingemer, H and Bundke, U (2009), Ice Nuclei Concentration under different Meteorological Conditions in Israel, The 18th International Conference on Nucleation & Atmospheric Aerosols, 2009, August 10-14, Prague, Czech Republic.

Ardon-Dryer, K. and Z. Levin: On the changes in ice nuclei concentrations during a dust storm event. Israel Meteorological Organization, annual conference, In Hebrew, Raanana, 2009.

Ardon-Dryer, K. and Z. Levin: Measurement of Immersion Freezing Nuclei in Antarctica, Israel Aerosol Organization, annual conference, Jerusalem, 2009.

Burkhardt, U. (2008), Global modeling of contrail cirrus. Omega Workshop, Oxford, UK (invited oral presentation).

Burkhardt, U. and B. Kärcher (2008), Process based simulation of contrail cirrus. ECATS Workshop on Contrails, Contrail Cirrus, their Forecasting and Mitigation, Hohenkammer, Germany.

Burkhardt, U., B. Kärcher and J. Hendricks (2009), Cirrus, Contrails and Indirect Effects of Ice Nuclei: Modelling and Validation, Globcloud Workshop 'Clouds: from satellite observations to atmospheric modelling', Berlin, Germany.

Burkhardt, U., J. Hendricks and B. Kärcher (2009), Ice clouds and aerosols in ECHAM. COSMOS Meeting, Berlin, Germany.

Burkhardt, U. and B. Kärcher (2009), Climate impact of contrail cirrus. TAC-2, Aachen, Germany.

Burkhardt, U. and B. Kärcher (2009), Contrail cirrus and their impact on cirrus cloudiness and global radiative forcing, AGU Fall Meeting, San Francisco.

Burkhardt, U. and B. Kärcher (2010), How large is the global radiative forcing from contrail cirrus?, Quantify Final Meeting, München (invited oral presentation).

Burkhardt, U., B. Kärcher and J. Hendricks (2010), Cirrus Coverage in ECHAM, HAMMOZ-Meeting, Zürich.

Clauss T., A. Kiselev, P.H. Kaye, E. Hirst, R. Greenaway, J. Ulanowski, E. Hesse and M. Schnaiter (2010) Characterization of ice particles by spatial light scattering with the novel optical particle detector LISA. IAC 2010.

Hartmann, S., Niedermeier, D., Wex, H., Kiselev, A., Shaw, R. A., Voigtländer, J., Clauss, T., and Stratmann, F. (2009), Model simulation studies concerning heterogeneous and homogeneous ice nucleation at LACIS, European Aerosol Conference (EAC) 2009, September 6-11, Karlsruhe, Germany.

Hendricks, J., and B. Kärcher (2010), Effects of soot from aviation on cirrus, QUANTIFY final meeting, 25.-27. January 2010, Munich, Germany (invited oral presentation).

Henning, S., et al. (2008), Relationship between hygroscopicity / CCN efficiency and ice nucleation potential of coated and uncoated soot – results from the AIDA campaign IN11, poster presented at ICCP, Cancun, Mexico.

- Hoose, C., U. Lohmann, R. Erdin, and I. Tegen (2007), Global Influence of Dust Mineralogy on Heterogeneous Ice Nucleation, paper presented at IUGG, Perugia, Italy.
- Hoose, C. and Lohmann, U., 2008: Dust impacts on warm and cold clouds: Insights from global models. 3rd International Workshop on Mineral Dust, Leipzig, Germany (invited oral presentation).
- Kiselev A., T. Clauss, P.H. Kaye, E. Hirst, R. Greenaway, J. Ulanowski, E. Hesse and M. Schnaiter (2010) Measurements of circular depolarization of light scattered from single ice particles. In: Proc. 12th Int. Conf. Electromagnetic & Light Scatt., Helsinki
- Klimach, T., M. Brands, F. Drewnick, J. Schneider, M. Kamphus, and S. Borrmann, Performance comparison of two different Laser Ablation Time-of-Flight Mass Spectrometers, submitted to EAC, Karlsruhe, 2009.
- Levin, Z.: Aerosol impact on precipitation, The Goldschmidt Conference, Davos, 2009.
- Levin, Z.: Aerosol impact on precipitation; *Is there a clear anti-correlation between aerosols and precipitation?* IAMAS Conference, Montreal, 2009.
- Lohmann, U: "Impact of aerosols on mixed-phase and cirrus clouds: Results from global studies", invited talk at IAMAS conference, Montreal, July 25, 2009.
- Lohmann, U.: "Influence of anthropogenic aerosols on climate by acting as cloud condensation and ice nuclei", invited talk at ICNAA conference, Prague Aug 14, 2009
- Lüönd, F., Experimental Study on Immersion Freezing under Mixed Phase Cloud Conditions, British Association for Crystal Growth Conference 2008, Loughborough, 7 – 9 September 2008.
- Möhler, O., P. J. DeMott, and O. Stetzer (2008), The fourth international ice nucleation workshop ICIS-2007, paper presented at 15th International Conference on Clouds and Precipitation, Cancún, México, 7-11 July 2008.
- Möhler, O., J. Schneider, S. Walter, A. J. Heymsfield, C. Schmitt, and Z. J. Ulanowski (2008), How coating layers influence the deposition mode ice nucleation on mineral particles, paper presented at 15th International Conference on Clouds and Precipitation, Cancún, México, 7-11 July 2008.
- Niedermeier, D., Hartmann, S., Shaw, R. A., Covert, D., Mentel, Th. F., Schneider, J., Poulain, L., Reitz, P., Spindler, C., Clauss, T., Kiselev, A., Hallbauer, E., Wex, H., Mildenerger, K., and Stratmann, F. (2009), FROST - Freezing and activation abilities of coated and uncoated mineral dust particles, IAMAS, IAPSO, IACS - Joint Assembly (MOCA) , 2009, July 19-29, Montréal, Canada.
- Niedermeier, D., Hartmann, S., Shaw, R. A., Covert, D., Mentel, Th. F., Schneider, J., Poulain, L., Reitz, P., Spindler, C., Clauss, T., Kiselev, A., Hallbauer, E., Wex, H., Mildenerger, K., and Stratmann, F. (2009), Freezing and Activation Measurements of Coated and Uncoated Arizona Test Dust Particles - Results of the Measurement Campaign FROST, 18th international conference on nucleation and atmospheric aerosols (ICNAA), August 10-14, Prague, Czech Republic.
- Niedermeier, D., Hartmann, S., Shaw, R. A., Covert, D., Mentel, Th. F., Schneider, J., Poulain, L., Clauss, T., Kiselev, A., Hallbauer, E., Wex, H., Mildenerger, K., and Stratmann, F. (2009), Freezing and Activation Measurements of Coated and Uncoated Arizona Test Dust Particles, European Aerosol Conference (EAC) 2009, September 6-11, Karlsruhe, Germany.
- Niedermeier, D., S. Hartmann, T. Clauss, A. Kiselev, R. Sullivan, P. DeMott, O. Stetzer, B. Reimann, U. Bundke, R. A. Shaw, Th. F. Mentel, P. Reitz, J. Schneider, B. Sierau, H. Wex, and F. Stratmann, Heterogeneous freezing of droplets with immersed mineral dust particles – Experimental study of the role of chemical and physical surface processing, submitted to IAC Helsinki, 2010.

- Niemand, M., S. Benz, O. Möhler, and T. Leisner (2009) AIDA-Wolkenkammerexperimente zur heterogenen Eisnukleation in Zirruswolken, oral presentation at DPG-Frühjahrstagung, Hamburg, 3.-6. März 2009
- Reitz, P., J. Schneider, H. Wex, F. Stratmann, D. Niedermeier, K. Mildenerger, D. Covert, Th. F. Mentel, C. Spindler, L. Poulain, and S. Borrmann, Detection of thin coatings on refractory particles with an aerosol mass spectrometer and application in laboratory studies of hygroscopic growth, CCN and IN activation, poster presentation, EAC Karlsruhe, 2009.
- Reitz, P., J. Schneider, H. Wex, F. Stratmann, D. Niedermeier, K. Mildenerger, D. Covert, Th. F. Mentel, C. Spindler, L. Poulain, and S. Borrmann, Thin Coatings On Refractory Particles: Detection With Mass Spectrometry And Implications For Studies Of Hygroscopic Growth, CCN And IN Activation, oral presentation, ICNAA, Prague, 2009.
- Reitz P., Schneider J., Wex H., Stratmann F., Niedermeier D., Mildenerger K., Hartmann S., Kiselev A., Shaw R.A., Covert D., Buchholz A., Spindler C., Mentel Th. F., Poulain L., Sullivan R., DeMott P.J., Borrmann S., Surface modification of mineral dust particles by thin coatings: Implications for CCN and IN abilities, submitted to IAC Helsinki, 2010.
- Stopford C., Z. Ulanowski, E. Hesse, P.H. Kaye, E. Hirst, M. Schnaiter, and D. McCall (2008) Initial investigation into using Fourier spectra as a means of classifying ice crystal shapes. In: *Proc. 11th Int. Conf. Electromagnetic & Light Scatt.*, Hatfield, pp.247-250.
- Sullivan, Ryan, Petters, Markus, DeMott, Paul, Kreidenweis, Sonia, Wex, Heike, Niedermeier, Dennis, Stratmann, Frank, Reitz, Paul, and Schneider, Johannes, Irreversible loss of ice nucleation surface sites in mineral dust particles induced by sulphuric acid condensation, submitted to IAC Helsinki, 2010.
- Ulanowski Z., C. Stopford, E. Hesse, P. H. Kaye, E. Hirst, and M. Schnaiter (2007) Characterization of small ice crystals using frequency analysis of azimuthal scattering patterns. In: *Proc. 10th Int. Conf. on Electromagnetic & Light Scatt.*, 17-22 June, Bodrum, pp.225-228.
- Ulanowski Z., C. Stopford, E. Hesse, P.H. Kaye, E. Hirst, R. S. Greenaway and M. Schnaiter (2008) Small Ice Detector 2: Characterization of Ice Crystals Using Analysis of Azimuthal Scattering Patterns. *EGU General Assembly*, Vienna 13-18 April.
- Ulanowski Z., P. H. Kaye, E. Hirst, R. Greenaway, E. Hesse and M. Schnaiter (2009) Ice particle characterization using SID-3 probe during nucleation experiments in AIDA cloud chamber. Royal Meteorological Society Conference, Reading.
- Ulanowski Z. (2010a) Light scattering by ice particles in the Earth's atmosphere and related laboratory measurements. 12th Int. Conf. Electromagnetic & Light Scatt., Helsinki (invited).
- Unterstrasser, S and K. Gierens (2009), Simulations of contrail-to-cirrus transition: Study of the radiative impact on contrail evolution, TAC2-Konferenz, Aachen, Germany.
- Wex, H., Burkhardt, J., Clauss, T., Covert, D., Hallbauer, E., Hartmann, S., Hitzengerger, R., Kiselev, A., Mentel, Th.F., Mildenerger, K., Niedermeier, D., Poulain, L., Reitz, P., Schmale, J., Schneider, J., Borrmann, S., Shaw, R., Spindler, C., Stratmann, F. (2009), FROST-I: freezing of coated and uncoated dust particles, EGU General Assembly (EGU) 2009, April 20-24, Vienna, Austria.
- Wex, H., Niedermeier, D., Hartmann, S., Burkhardt, J., Clauss, T., Covert, D., Hallbauer, E., Hitzengerger, R., Kiselev, A., Mentel, Th.F., Mildenerger, K., Poulain, L., Reitz, P., Schmale, J., Schneider, J., Borrmann, S., Shaw, R., Spindler, C., Stratmann, F. (2009), FROST - FReezing Of duST, Goldschmidt 2009, June 21-26, Davos, Switzerland.
- Ziese, M., S. Henning, K. Mildenerger, F. Stratmann, O. Möhler, S. Benz, A. Buchholz, Th. Mentel (2008) Hygroscopic growth and activation of uncoated and coated soot particles

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Ziese, M., Henning, S., Mildenerger, K., Stratmann, F., Möhler, O., Benz, S., Buchholz, A., Spindler, C., Mentel, Th.F., and the AIDA/LACIS-mobile-team (2009), Hygroscopic growth and activation of uncoated and coated soot particles and their relation to ice nucleation, EGU General Assembly (EGU 2009), Vienna, Austria.

Ziese, M., Henning, S., Mildenerger, K., Stratmann, F., Möhler, O., Benz, S., Buchholz, A., Spindler, C., Mentel, Th., and the AIDA/LACIS-mobile-team (2009), Hygroscopic growth and activation of uncoated and coated soot particles and their relation to ice nucleation, European Aerosol Conference (EAC) 2009, September 6-11, Karlsruhe, Germany.