Atmospheric chemistry lecture course

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1. Course materials accessable

http://www.ak-hoffmann.chemie.uni-mainz.de/at_chem_e.htm

2. Recommended textbooks

Atmospheric chemistry:

Finlayson-Pitts BJ, Pitts JN: Chemistry of the upper and lower atmosphere, San Diego (Academic Press), 2nd ed., 1998

Jacobson MZ: Atmospheric pollution: History, science, and regulation, Cambridge/UK (Cambridge University Press), 2002, 399 pp.

Warneck P: Chemistry of the natural atmosphere (International Geophysics Vol. 71), San Diego (Academic Press), 2nd ed., 2000

Zellner R et al.: Atmosphärenchemie, Chemie in unserer Zeit 41 (2007) 133-295 (Special issue), Weinheim/Germany (Wiley-VCH)

Atmospheric physics:

Salby ML: Fundamentals of atmospheric physics, San Diego (Academic Press), 1st ed., 1996, 624 pp.

Visconti G: Fundamentals of physics and chemistry of the atmosphere, Berlin (Springer), 2001, 592 pp.

Wallace JM, Hobbs PV: Atmospheric Sciences, Burlington/USA (Academic Press), 2006, 483 pp.

Chemical kinetics:

Barrow GM: Physical chemistry, New York (McGraw-Hill), 6th ed., 1996

Aerosols:

Seinfeld JH, Pandis SN: Atmospheric chemistry and physics - from air pollution to climate change, Weinheim/Germany (Wiley-VCH), 2nd ed., 2006

Multicompartmental chemistry:

Klöpffer W: Verhalten und Abbau von Umweltchemikalien, Landsberg (Ecomed), Germany 1996

Schwartzenbach RP, Gschwend PM, Imboden DM: Environmental organic chemistry, New York (Wiley), 2nd ed., 2002

3. References made in the lecture course

Abraham MH, Whiting GS, Doherty RM, Shuely WJ (1991): Hydrogen bonding. XVII. The characterisation of 24 gas-liquid chromatographic stationary phases studied by Poole and co-workers including molten salts, and evaluation of solute-stationary phase interactions, J. Chromatogr. 587, 229–236

Abraham MH (1993): Scales of solute hydrogen-bonding: Their construction and application to physicochemical and biochemical processes, Chem. Soc. Rev. 22, 73–83

Acker K, Febo A, Trick S, Perrino C, Bruno P, Wiesen P, Möller D, Wieprecht W, Auel R, Giusto M, Geyer A, Platt U, Allegrini I (2006): Nitrous acid in the urban area of Rome, Atmos. Environ. 40, 3123-3133

Akimoto H, Takagi H, Sakamaki F (1987): Photoenhancement of the nitrous acid formation in the surface reaction of NO2 and water vapor: Extra radical source in smog chamber experiments, Int. J. Chem. Kin. 19, 539-551

Alcamo J, Ammann M, Hettelingh JP, Holmberg M, Hordijk L, Kämäri L, Kauppi P, Kornai G, Mäkelä M (1987): Acidifoication in Europe – A simulation model for evaluating control strategies, Ambio 16, 232-245

AMAP (2004) - Arctic Monitoring and Assessment Programme: Persistent organic pollutants in the Arctic, AMAP, Oslo, 310 pp.

Anastasio C, Faust BC, Allen JM (1994): Aqueous phase photochemical formation of hydrogen peroxides in authentic cloudwaters, J. Geophys. Res. 99, 8231-8248

Andreae MO (1995): Climate effects of changing atmospheric aerosol levels, World survey of climatology Vol. 14: Future climates of the world – a modelling perspective (Henderson-Sellers A, ed.), Amsterdam (Elsevier), pp. 341-392

Atkinson R, Baulch DL, Cox RA, Crowley JN, Hampson RF, Hynes RG, Jenkin ME, Rossi MJ, Troe J (2004): Evaluated kinetic and photochemical data for atmospheric chemistry: Volume I - gas phase reactions of O_x, HO_x, NO_x and SO_x species, Atmos. Chem. Phys. 4, 1461-1738

Atkinson R, Baulch DL, Cox RA, Crowley JN, Hampson RF, Hynes RG, Jenkin ME, Rossi MJ, Troe J (2006): Evaluated kinetic and photochemical data for atmospheric chemistry: Volume II – gas phase reactions of organic species, Atmos. Chem. Phys. 6, 3625-4055

Atkinson R, Baulch DL, Cox RA, Crowley JN, Hampson RF, Hynes RG, Jenkin ME, Rossi MJ, Troe J (2007): Evaluated kinetic and photochemical data for atmospheric chemistry: Volume III – gas phase reactions of inorganic halogens, Atmos. Chem. Phys. 7, 981-1191

Barrie LA, Bottenheim JW, Schnell RC, Crutzen PJ, Rasmussen RA (1988): Ozone destruction and photochemical reactions at polar sunrise in the lower Arctic atmosphere, Nature 334, 138–141

Becker KH (1991): Atmosphärenchemie, Umweltwiss. Schadstofforschung 3, 48-51

Böhme F, Welsch-Pausch K, McLachlan MS (1999): Uptake of airborne semivolatile organic compounds in agricultural plants: field measurements of interspecies variability, Environ. Sci. Technol. 33, 1805-1813

Brune W, Levy H, Dorn HP, Hofzumahaus A, Yurganov L, Wang Y (2000) : Cleansing the atmosphere: Hydroxyl radicals, IGACtivities Newsletter No. 21

Burkholder JB, Orlando JJ, Howard CJ (1990): Ultraviolet absorption cross section of Cl_2O_2 between 210 and 410 nm, J. Phys. Chem. 94, 687-695

Busch G, Lammel G, Beese FO, Dentener FJ, Feichter J, Roelofs GJ (2001): Forest ecosystems and the patterns of nitrogen input and acid deposition today and projected into the future based on a scenario, Environ. Sci. Poll. Res. 8, 95-102

Butkovskaya N, Kukui A, Pouvesles N, le Bras G (2005): Formation of nitric acid in the gas phase HO_2 + NO reaction : effects of temperature and water vapour. J. Phys. Chem. 109A, 6509-6520

Calvert JG, Lazrus AL, Kok GL, Heikes BG, Walega JG, Lind JA, Cantrell CA (1985): Chemical mechanism of acid generation in the troposphere, Nature 317, 27-35

Carter WPL (1994): Development of ozone reactivity scales for volatile organic compounds, J. Air Waste Manage. Assoc. 44, 881-899

Chapman S (1930): A theory of upper atmospheric ozone, Q. J. R. Meteorol. Soc. 3, 103

Charlson RJ, Lovelock JE, Andreae MO, Warren SG (1987): Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate, Nature 326, 655-661

Chubachi S (1985): Special ozone observations at Syowa Station, Antarctica, from February 1982 to January 1983, in: Atmospheric ozone (Zerefos CS, Ghazi A, eds.), Dordrecht/the Netherlands (Reidel), pp. 285–289

Ciani A, Goss KU, Schwarzenbach RP (2005): Determination of molar absorption coefficients of organic compounds adsorbed in porous media, Chemosph. 61, 1410-1418

Crowley JN, Carl SA (1997): OH formation in the photoexcitation of NO_2 beyond the dissociation threshold in the presence of water vapor, J. Phys. Chem. A 101, 4178-4184

Crutzen PJ (1970): Influence of nitrogen oxides on atmospheric ozone content, Q. J. R. Met. Soc. 96, 320

Crutzen PJ (1983): Atmospheric interactions – homogeneous gas reactions of C, N and S containing compounds, in: The Major Biogeochemical Cycles (Bolin B, Cook RB, eds.), SCOPE Vol. 21, Chichester (Wiley), 554 pp.

Crutzen PJ, Gidel LT (1983): A two-dimensional photochemical model of the atmosphere. 2. The tropospheric budgets of the anthropogenic chlorocarbons, CO, CH_4, CH_3Cl and the effect of various NO_x sources on tropospheric ozone, J. Geophys. Res. 88, 6641-6661

Dameris M, Peter T, Schmidt U, Zellner R (2007): Das Ozonloch und seine Ursachen, Chem. in unserer Zeit 41, 152-168

Davidson EA (1991): in: Microbial Production and Consumption of Greenhouse Gases: Methane, Nitrogen Oxides and Halomethanes (Rogers JE, Whitman WB, eds.), Washington (Am. Soc. Microbiol.), pp. 219–235

Decesari S, Facchini MC, Matta E, Mircea M, Fuzzi S, Chughtai AR, Smith DM (2002): Water-soluble organic carbon formed by oxidation of soot, Atmos. Environ. 36, 1827-1832

Dentener F, Stevenson D, Ellingsen K, von Noije T, Schultz M, Amann M, Atherton C, Bell N, Bergmann D, Bey I, Bowman L, Cofala J, Collins B, et al. (2006): The global atmospheric environment for the next generation, Environ. Sci. Technol. 40, 3586-3594

de More WB, Sander SP, Golden DM, Hampson RF, Kurylo MJ, Howard CJ, Ravishankara AR, Kolb CE, Molina MJ (1997): Chemical kinetics and photochemical data for use in stratospheric modeling, Report No. JPL 97-4, NASA Jet Propulsion Laboratory, Pasadena/USA

Derwent RG, Stevenson DS, Collins WJ, Johnson CE (2004): Intercontinental transport and the origins of the ozone observed at surface sites in Europe, Atmos. Environ. 38, 1891-1901

Dlugi R, Jordan S (1982): Heterogeneous SO_2-oxidation: Its contribution to the cloud condensation nuclei formation process, Idöjárás 86, 82-88

Dorn HP, Callies J, Platt U, Ehhalt DH (1988): Measurement of tropospheric OH concentration by laser long-path absoprtion spectrometry, Tellus 40B, 437-445

Ebert M, Weinbruch S, Hoffmann P, Ortner HM (2000): Chemical characterization of North Sea aerosol particles, J. Aerosol Sci. 31, 613-632

Ehhalt DH (1986) On the consequence of tropospheric CH_4 increase to the exospheric density, J. Geophys. Res. 91, 2843

Ehhalt DH (1999): Photooxidation of trace gases in the troposphere, Phys. Chem. Chem. Phys. 1, 5401-5408

EK (1994) – Enquête-Kommission des Dt. Bundestags 'Schutz der Erdatmosphäre': Bundestagsdrucksache

Enya T, Suzuki H, Watanabe T, Hirayama T, Hisamatsu Y (1997): 3-Nitrobenzanthrone, a powerful bacterial mutagen and suspected human carcinogen found in diesel exhausts and airborne particulates, Environ. Sci. Technol. 31, 2772-2776

Farman JC, Gardiner BG, Shanklin JD (1985): Large losses of total ozone in Antarctica reveal seasonal ClO_x/NO_x interaction, Nature 315, 207-210

Feichter J, Roeckner E, Lohmann U, Liepert B (2004): Nonlinear aspects of the climate response to greenhouse gas and aerosol forcing, J. Clim. 17, 2384-2398

Finizio A, Mackay D, Bidleman TF, Harner T (1997): Octanol-air partitioning coefficient as a predictor of partitioning of semivolatile organic compounds to aerosol, Atmos. Environ. 31, 2289-2296

Finlayson-Pitts BJ, Pitts JN (1998): Chemistry of the upper and lower atmosphere, San Diego (Academic Press), 2nd ed.

Flocke F, Volz-Thomas A, Buers HJ, Pätz W, Garthe HJ, Kley D (1998): Longterm measurements of alkyl nitrates in southern Germany - 1. General behaviour and seasonal and diurnal variation, J. Geophys. Res. 103, 5729-5746

Franklin J, Atkinson R, Howard PH, Orlando JJ, Seigneur C, Wallington TJ, Zetzsch C (2000): Quantitative determination of persistence in air. In: Criteria for persistence and long-range transport of chemicals in the environment (Klečka G et al., eds.), Pensacola/ USA (SETAC Press), pp. 7-62

Fehrenbach T (2007): Analyse von Aminosäuren, Proteinen und Nitroderivaten in atmosphärischen Aerosolen und in Straßenstaub, PhD Thesis, Technical University of Munich, 288 pp.

Franze T, Weller MG, Niessner R, Pöschl U (2003): Enzyme immunoassays for the investigation of protein nitration by air pollutants, Analyst 128, 824-831

Fuchs NA, Sutugin AG (1971): High-dispersed aerosols, in: Topics in current aerosol research (Hidy GM, Brock JR, eds.), New York (Pergamon), pp. 1-60

Fuzzi S, Decesari S, Facchini MC, Matta E, Mircea M (2002): A simplified model of the water-soluble organic carbon of atmospheric aerosols, Geophys. Res. Lett. 20, 4079-4082

Gelencser A, Hoffer A, Kiss G, Tombácz E, Kurdi D, Bencze L (2003): In situ-formation of light-absorbing organic matter in cloudwater, J. Atmos. Chem. 45, 25-33

Gerosa G, Cieslik S, Ballarin-Denti A (2002): Partitioning of ozone fluxes between stomatal and other pathways over a wheat field in the Po river plain during the growing season, in: Transport and chemical

transformation in the troposphere (Midgley P, Reuther M, eds.), Proceedings EUROTRAC2 Conference, Garmisch-Partenkirchen/Germany, 11-15 March 2002, Weikersheim/Germany (Margraf)

Glotfelty DE, Majewski MS, Seiber JN (1990): Distribution of several organophosphorous insecticides in a foggy atmosphere, Environ. Sci. Technol. 24, 353-357

Goss KU (2004): The air-surface adsorption equation of organic compounds under ambient conditions, Crit. Rev. Environ. Sci. Technol. 34, 339-389

Goss KU, Schwarzenbach RP (2001): Linear free energy relationships used to evaluate equilibrium partitioning of organic compounds, Environ. Sci. Technol. 35, 1–9

Graedel TE, Weschler CJ (1981): Chemistry within aqueous atmospheric aerosols and raindrops, Rev. Geophys. Space Phys. 19, 505-539

Granier C, Kanakidou M, Kasibhalta P (2003): Modeling, in: The atmospheric chemistry in a changing world (Brasseur GB, Prinn RG, Pszenny AAP, eds.), Berlin (Springer), pp. 185-206

Grayson BT, Kleier DA (1990): Phloem mobility of xenobiotics. IV. Modelling of pesticide movement in plants, Pestic. Sci. 30, 67–79

Griffin RJ, Cocker DR, Seinfeld JH, Dabdub D (1999): Estimation of global organic aerosol from oxidation of biogenic hydrocarbons, Geophys. Res. Lett. 26, 2721-2724

Guenther A, Hewitt CN, Erickson D, Fall R, Geron C, Graedel T, Harley P, Klinger L, Lerdau M, McKay WA, Pierce T, Scholes, Steinbrecher R, Tallamraju R, Taylor J, Zimmerman P (1996): A global model of natural volatile organic carbon emissions, J. Geophys. Res. 100, 8837-8892

Guglielmo F, Lammel G (2006): Global cycling of semivolatile organic compounds: A coupled 3D atmosphere-ocean approach, 16th SETAC Europa Annual Meeting, den Haag, 7.-11.5.2006

Harner T, Bidleman TF (1998): Ocatnol-air partitioning coefficients for describing particle/gas partitioning of aromatic compounds in urban air, Environ. Sci. Technol. 32, 1494-1502

Hasson AS, Tyndall GS, Orlando JJ (2004): A product yield study of the reaction of HO_2 with ethylperoxy ($C_2H_5O_2$), acetylperoxy ($CH_3C(O)O_2$), and acetonylperoxy ($CH_3C(O)CH_2O_2$) radicals, J. Phys. Chem. 108A, 5979-5989

Hauck H, Berner A, Frischer T, Gomiscek B, Kundi M, Neuberger M, Puxbaum H, Preining O & AUPHEP-Team (2004), AUPHEP—Austrian project on health effects of particulates—general overview, Atmospheric Environment 38, 3905–3915

Havers N, Burba P, Lambert J, Klockow D (1998): Spectroscopic characterization of humic-like substances in ariborne particulate matter, J. Atmos. Chem. 29, 45-54

Hebestreit K, Stutz J, Rosen D, Matveiv V, Peleg M, Luria M, Platt U (1999): DOAS measurements of tropospheric bromine oxide in mid-latitudes, Science 283, 55-57

Herrmann H (2003): Kinetics of aqueous phase reactions relevant for atmospheric chemistry, Chem. Rev. 103, 4691-4716

Herrmann H, Brüggemann E, Gnauk T, Müller K, Iinuma Y, Beiner K, Poulain L (2007): Ultrafine particles chemical content, UFIPOLNET Final Conference, Dresden, 23-24 October 2007, http://www.umwelt.sachsen.de/de/wu/umwelt/lfug/lfug-internet/luft-laerm-klima_16566.html

Hibbard KA, Crutzen PJ, Lambin EF, Liverman D, Mantua NJ, McNeill JR, Messerli B, Steffen W (2006): Decadal interactions of humans and the environment, in: Integrated History and Future of People on Earth (Cstanza R, Graumlich L, Steffen W, eds.), Dahlem Workshop Rep. No. 96, Cambridge/USA (MIT Press), pp. 341-375

Hoffmann T, Zetzsch C, Rossi MJ (2007): Chemie von Aerosolen, Chem. in unserer Zeit 41, 232-246

Horowitz LW, Walters S, Mauzerall DL, Emmons LK, Rasch PJ, Granier C, Tie XX, Lamarque JF, Schultz MG, Tyndall GS, Orlando JJ, Brasseur GP (2003): A global simulation of tropospheric ozone and related tracers: Description and evaluation of MOZART, version 2, J. Geophys. Res. 108, Art. No. 4784

Hudman RC, Jacob DJ, Cooper OR, Evans MJ, Heald CL, Park RJ, Fehsenfeld F, Flocke F, Holloway J, Hübler G, Kita K, Koike M, Kondo Y, Neuman A, Nowak J, Oltmans S, Parrish D, Roberts JM, Ryerson T (2003): Ozone production in transpacific Asian pollution plumes and implications for ozone air quality in California, J. Geophys. Res. 109, Art. No. D23S10

Ilyina T, Pohlmann T, Lammel G, Sündermann J (2006): A fate and transport ocean model for persistent organic pollutants and its application for the North Sea, J. Marine Systems 63, 1-19

IPCC (2007) - Intergovernmental Panel on Climate Change: Climate Change 2007 – The Physical Science Basis (Solomon S et al., eds.), Contribution of Working Group I to the Forth Assessment Report of the IPCC, Cambridge/UK (Cambridge University Press), 996 pp.

Iwata H, Tanabe S, Sakai N, Tasukawa R (1993): Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate, Environ. Sci. Technol. 27, 1080-1098

Jaenicke R (1988): Aerosol physics and chemistry, Landolt-Börnstein Neue Serie 4b, 391-457

Jacobson MC (2005): Fundamentals of atmospheric modelling, 2nd ed.

Jantunen LM, Bidleman TF (1995): Reversal of the air-water gas-exchange direction of hexachlorocyclohexanes in the Bering and Chukchi Seas: 1993 vs. 1988, Environ. Sci. Technol. 29, 1081-1089

Jenkin ME (2004): Analysis of sources and partitioning of oxidant in the UK - Part 1: the NO_X-dependence of annual mean concentrations of nitrogen dioxide and ozone, Atmos. Environ. 38, 5117-5129

Johnston HS (1971): Reduction of stratospheric ozone by nitrogen oxide catalysts from supersonic transport exhaust, Science 173, 517-522

Johnston HS, Whitten G, Birks J (1974) Effect of nuclear explosions on stratospheric nitroc-oxide and ozone, J. Geophys. Res. 78, 6107-6135

Judeikis HS, Siegel S, Stewart TB, Hedgpeth HR, Wren AG (1979): Laboratory studies of heterogeneous reactions of oxides of nitrogen, in: Nitrogenous Air Pollutants (Grosjean D, ed.), Ann Arbor/USA (Ann Arbor Science), pp. 83-109

Junge CF (1977): Fate of pollutants in the air and water environment, in: Basic considerations about trace constituents in the atmosphere as related to the fate of global pollutants (Suffet I.H., ed.), Wiley, New York, pp. 7-25

Kaminski U (2006): Aktuelle Aerosoltrends an der GAW Globalstation Hohenpeißenberg und ihre Relevanz für Luftreinhaltung und Klima, Umweltwiss. Schadstofforschung 18, 88-94

Kaupp H, Umlauf G (1992): Atmospheric gas-particle partitioning of organic compounds: a comparison of sampling methods, Atmos. Environ. 26A, 2259-2267

Kleffmann J, Wiesen P (2005): Heterogeneous conversion of NO_2 and NO on HNO_3 treated soot surfaces: Atmospheric implications, Atmos. Chem. Phys. 5, 77-83

Kleffmann J, Becker KH, Wiesen P (1998): Heterogeneous NO_2 conversion processes on acid surfaces: Possible atmospheric implications, Atmos. Environ. 32, 2721-2729

Kleffmann J, Kurtenbach R, Lorzer J, Wiesen P, Kalthoff N, Vogel B, Vogel H (2003): Measured and simulated vertical profiles of nitrous acid in field measurements and in model simulations and indications for a photolytic source, Atmos. Environ. 37, 2949-2966

Klemm O, Wrzensinsky T, Scheer C (1995): Fogwater flux at a canopy top: Direct measurement vs. one-dimensional model, Atmos. Environ. 39, 5375-5386

Klöpffer W (1994): Environmental hazard - assessment of chemicals and products – 2. Persistence and degradability of organic chemicals, Environ. Sci. Pollut. Res. 1, 108-116

Koch R, Knispel R, Elend M, Siese M, Zetzsch C (2007): Consecutive reactions of aromatic-hydroxyl adducts with NO, NO_2, and O_2: benzene, naphthalene, toluene, m-and p-xylene, hexamethylbenzene, phenol, n-cresol and aniline, Atmos. Chem. Phys. 7, 2057-2071

Kramp F, Volz-Thomas A (1997): On the budget of OH radicals and ozone in an urban plume from the decay of C5-C8 hydrocarbons and NO_x, J. Atmos. Chem. 28, 263-282

Krivacsy Z, Gelencser A, Kiss G, Meszáros E, Molnar E, Hoffer A, Meszáros T, Sarvari Z, Temesi D, Varga B, Baltensperger U, Nyeki S, Weingartner E (2001) : Study on the chemical characterisation of water-soluble organic compounds in fine aerosols at Jungfraujoch, J. Atmos. Chem. 39, 235-259

Krol MC , Lelieveld J, Oram DE, Sturrock GA, Penkett SA, Brenninkmeijer CAM, Gros V, Williams J, Scheeren HA (2003): Continuing emissions of methyl chloroform from Europe, Nature 421, 131-135

Kroll G, Winkler P (1989): Influence of meteorological parameters on interception of cloud droplets in a coniferous forest, Contrib. Atmos. Phys. 62, 265-274

Kubátová A, Vermeylen P, Claeys M, Cafmeyer J, Maenhaut W, Roberts G, Artaxo P (2000): Carbonaceous aerosol characterization in the Amazon basin, Brazil: Novel dicarboxylic acids and related compounds, Atmos. Environ. 34, 5037-5051

Kunit M, Puxbaum H (1996): Enzymatic determination of the cellulose content of atmospheric aerosols, Atmos. Environ. 30, 1233-1236

Kwok ESC, Atkinson R, Arey J (1996): Isomerization of beta-hydroxyalkoxy radicals formed from the OH radical initiated reactions of C_4-C_8 1-alkenes, Environ. Sci. Technol. 30, 1048-1052

Labitzke K, van Loon H (1999): The Stratosphere - phenomena, history, and relevance, Springer, Berlin, 179 pp.

Lakaschus S, Weber K, Wania F, Schrems O (2002): The air-sea equilibrium and time trend of hexachlorocyclohexane in the Atlantic ocean between the Arctic and Antarctic, Environ. Sci. Technol. 36, 138-145

Lammel G (1996): Formation of nitrous acid: Parameterisation and comparison with observations, Report No. 286, Max Planck Institute for Meteorology, Hamburg, 36 pp.

Lammel G, Cape JN (1996): Nitrous acid and nitrite in the atmosphere, Chem. Soc. Rev. 25, 361-369

Lammel G, Perner D, Warneck P (1990): Decomposition of pernitric acid in aqueous solution, J. Phys. Chem. 94, 6141-6144

Lammel G, Brüggemann E, Gnauk T, Müller K, Neusüß C, Röhrl A (2003): A new method to study aerosol source contributions along the tracts of air parcels and its application to the near-ground level aerosol chemical composition in central Europe, J. Aerosol Sci. 34, 1-25

Lammel G, Schneider F, Brüggemann E, Gnauk T, Röhrl A, Wieser P (2004): Aerosols emitted from a livestock farm in southern Germany, Water Air Soil Poll. 154, 313-330

Lee YN, Schwartz SE (1981): Evaluation of the rate of uptake of NO_2 by atmospheric and surface liquid water, J. Geophys. Res. 86, 11971-11983

Leip A, Lammel G (2004): Indicators for persistence and long-range transport potential as derived from multicompartment chemistry-transport modelling, Environ. Poll. 128, 205-221

Lelieveld J, Crutzen PJ (1990): Influences of cloud photochemical processes on tropospheric ozone, Nature 343, 227-233

Lelieveld J, Peters W, Dentener FJ, Krol MC (2002): Stability of tropospheric hydroxyl chemistry, J. Geophys. Res. 107, Art. No. 4715

Li SP, Matthews J, Sinha A (2008): Atmospheric hydroxyl radical production from electronically excited NO_2 and H_2O, Science 319, 1657-1660

Liss PS, Slater PG (1974): Flux of gases across the air-sea interface, Nature 247,181-184

Lohmann U, Feichter J (2001): Can the direct and semi-direct aerosol effect compete with the indirect effect on a global scale? Geophys. Res. Lett. 28, 159-162

Lohmann R, Lammel G (2004): Adsorptive and absorptive contributions to the gas particle partitioning of polycyclic aromatic hydrocarbons: State of knowledge and recommended parameterisation for modeling, Environ. Sci. Technol. 38, 3793-3803

Manney GL, Santee ML, Froidevaux L, Waters JW, Zurek RW (1996): Polar vortex conditions during the 1995-96 arctic winter: Meteorology and MLS ozone, Geophys. Res. Lett. 23, 3203-3206

Martinez RD, Buitrago AA, Howell NW, Hearn CH, Joens JA (1992): The near-UV absorption spectra of several aliphatic aldehydes and ketones at 300 K, Atmos. Environ. 26A, 785-792

McFadyen GG, Cape JN (2005): Peroxyacetyl nitrate in eastern Scotland, Sci. Total Environ. 337, 213-222

McLachlan MS (1996): Bioaccumulation of hydrophobic chemicals in agricultural food chains, Environ. Sci. Technol. 30, 252-259

McLachlan MS, Welsch-Pausch K, Tolls J (1994): Field validation of a model of the uptake of gaseous semivolatile organic compounds in Lolium multiflorum (ray grass), Environ. Sci. Technol. 29, 1998-2004

Meijer SN, Steinnes E, Ockenden WA, Jones KC (2002): The influence of environmental and soil-related variables on the spatial distribution of PCBs in Norwegian and UK soils: implications for global cycling, Environ. Sci. Technol. 36, 2146-2153

Meng ZY, Seinfeld JH (1996): Time scales to achieve atmospheric gas-aerosol equilibrium for volatile species, Atmos. Environ. 30, 2889-2900

Molina L.T., Molina MJ (1987): Production of the Cl_2O_2 from the self-reaction of the ClO radical, J. Phys. Chem. 91, 433-436

Möller D (2003): Luft - Ursachen der Luftverschmutzung, Berlin (de Gruyter), 750 pp.

Oltmans SJ (1981): Surface ozone measurments in clean air, J. Geophys. Res. 86, 1174-1180

Oltmans SJ, Lefohn AS, Scheel HE, Harris JM, Levy H, Galbally IE, Brunke EG, Meyer CP, Lathrop JA, Johnson BJ, Shadwick DS, Cuevas E, Schmidlin FJ, Tarasick DW, Claude H, Kerr JB, Uchino O, Mohnen V (1998): Trends of ozone in the troposphere, Geophys. Res. Lett. 25, 139-142

Pankow JF (1987): Review and comparative analysis of the the theory of partitioning between the gas and aerosol particulate phases in the atmosphere, Atmos. Environ. 21, 2275-2283

Paterson S, Mackay D (1985): the fugacity concept in environmental modeling, in: Handbook of environmental chemistry Vol. 2C (Hutzinger O, ed.), Berlin (Springer), pp. 121-140

Penner JE, Andreae M, Annegarn H, Barrie L, Feichter J, Hegg D, Jayaraman A, Leaitch R, Murphy D, Nganga J, Pitari G (2001): Aerosols, their direct and indirect effects, in : Climate Change 2001 – The Scientific Basis (Houghton JD et al., eds.), Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge/UK (Cambridge University Press), pp. 289-348

Perner D, Platt U (1979): Detection of nitrous acid in the atmosphere by differential optical absorption, Geophys. Res. Lett. 6, 917-920

Pitts JN, Sanhueza E, Atkinson R, Carter WPL, Winer AM, Harris GW, Plum CN (1984): An investigation of the dark formation of nitrous acid in environmental chambers, Int. J. Chem. Kin. 16, 919-939

Platt U, Perner D, Winer AM, Harris GW, Pitts JN (1980): Detection of NO_3 in the polluted troposphere by differential optical-absorption, Geophys. Res. Lett. 7, 89-92

Pope FD, Hanson JC, Bayes KD, Friedl RR, Sander SP (2007): UV absorption spectrom chlorine peroxide, ClOOCl, J. Phys. Chem. 111A, 4322-4332

Pöschl U, Rudich Y, Ammann M (2007): Kinetic model framework for aerosol and cloud surface chemistry and gas-particle interactions – Part I: General equations, parameters, and terminology, Atmos. Chem. Phys. 7, 5989-6023

Ranson KJ, Wickland DJ (2001): EOS Terra - first data and mission status, Global Change Newsletter 45, 23-31, IGBP, Stockholm (Royal Swedish Academy of Sciences)

Ridley BA (1991): Recent measurements of oxidized nitrogen compounds in the troposphere, Atmos. Environ. 25A, 1905-1926

Rogers JD (1990): Ultraviolet absorption cross sections and atmospheric photodissociation rate constants of formaldehyde, J. Phys. Chem. 94, 4011-4015

Rogge WF, Hildemann LM, Mazurek MA, Cass GR, Simoneit BRT (1996): Mathematical modeling of fine particulate-associated primary organic compound concentrations, J. Geophys. Res. 101, 19379-19394

Roth CM, Goss KU, Schwarzenbach RP (2004): Sorption of diverse organic vapors to snow, Environ. Sci. Technol. 38, 4078-4084

Saliba NA, Yang H, Finlayson-Pitts BJ (2001): Reaction of gaseous NO with HNO_3 on silica surfaces in the presence of water at room temperature, J. Phys. Chem. 105A, 10339-10346

Schauer JJ, Rogge WF, Hildemann LM, Mazurek MA, Cass GR, Simoneit BRT (1996): Source apportionment of airborne particulate matter using organic compounds as tracers, Atmos. Environ. 30, 3837-3855

Schönherr J, Riederer M (1989): Foliar penetration and accumulation of organic chemicals in plant cuticles, Rev. Environ. Contam. Toxicol. 108, 1-70

Schroeder WH, Anlauf KG, Barrie LA, Lu JY, Steffen A, Schneeberger DR, Berg T (1998): Arctic springtime depletion of mercury, Nature 394, 331–332

Schwartz SE (1986): Mass-transport considerations pertinent to aqueous phase reactions of gases in liquid-water clouds, NATO ASI Ser. G6 (Jaeschke W, ed.), Heidelberg (Springer), pp. 415-471

Schwartz SE, Warneck P (1995): Units for use in atmospheric chemistry, Pure Appl. Chem. 67, 1377-1406

Schwartzenbach RP, Gschwend PM, Imboden DM: Environmental organic chemistry, Wiley, New York, 2nd ed. 2002

Sehili AM, Lammel G (2007): Global fate and distribution of polycyclic aromatic hydrocarbons emitted from Europe and Russia, Atmos. Environ. 41, 8301-8315

Seinfeld JH, Pandis SN (2006): Atmospheric chemistry and physics - From air pollution to climate change, Weinheim/Germany (Wiley-VCH), 2nd ed.

Semeena VS, Lammel G (2003): Effects of various scenarios upon entry of DDT and g-HCH into the global environment on their fate as predicted by a multicompartment chemistry-transport model, Fresenius Environ. Bull. 12, 925-939

Semeena VS, Lammel G (2005): The significance of the grasshopper effect on the atmospheric distribution of persistent organic substances, Geophys. Res. Lett. 32, L07804, doi:10.1029/2004GL022229

Sheih CM, Wesely ML, Hicks BB (1979): Estimated dry deposition velocities of sulfur over the eastern United States and surrounding regions, Atmos. Environ. 13, 1361-1368

Slinn WGN (1983): A potpourri of deposition and resuspension questions, in: Precipitation Scavenging, Dry Deposition and Resuspension Vol. 2 (Pruppacher HR, Semonin RG, Slinn WGN, eds.), New York (Elsevier), pp. 1361-1416

Smith DM, Akhter MS, Jassim JA, Sergides CA, Welch WF, Chughtai AR (1989): Studies of the structure and reactivity of soot, Aerosol Sci. Technol. 10, 311-325

Solomon S, Garcia RR, Rowland FS, Wuebbles DJ (1986): On the depletion of Antarctic ozone, Nature 321, 755-758

Solomon S (2004): What's news (and what's not) about the ozone hole, Nature 427, 289-291

Spindler G, Müller K, Brüggemann E, Gnauk T, Herrmann H (2004) : Long-term size segregated characterization of PM_{10}, $PM_{2.5}$ and PM_1 and the IfT research station Melpitz downwind of Leipzig (Germany), Atmos. Environ. 38, 5333-5347

Spivakovsky CM, Logan JA, Montzka SA, Balkanski YJ, Foreman-Fowler M, Jones DBA, Horowitz LW, Fusco AC, Brenninkmeijer CAM, Prather MJ, Wofsy SC, McElroy MB (2000): Three-dimensional climatological distribution of tropospheric OH: Update and evaluation, J. Geophys. Res. 105, 8931-8980

Steil B, Dameris M, Brühl C, Crutzen PJ, Grewe V, Ponater M, Sausen R (1998): Development of a chemistry module for GCMs: first results of a multiannual integration, Ann. Geophys. 16, 205-228

Stelson AW, Seinfeld JH (1982): Thermodynamic prediction of the water activity, NH_4NO_3 dissociation constant, dissociation constant, density and refractive index for the NH_4NO_3-$(NH_4)SO_4$-H_2O system at 25°C, Atmos. Environ. 16, 2507-2514

Stelson AW, Bassett ME, Seinfeld JH (1984): Thermodynamic equilibrium properties of aqueous solutions of nitrate, sulfate and ammonium, in: Chemistry of Particles, Fogs and Rains (Durham JL, ed.; Acid Precipitation Ser. Vol. 2), Stoneham/USA (Butterworth), pp. 1-52

Stier P, Feichter J, Kinne S, Kloster S, Vignati E, Wilson J, Ganzeveld L, Tegen I, Werner M, Schulz M, Balkanski Y, Boucher O, Minikin A, Petzold A (2005): The aerosol-climate model ECHAM5-HAM, Atmos. Chem. Phys. 5, 1125-1156

Svensson R, Ljungström E, Lindqvist O (1987): Kinetics of the reaction between NO_2 and water vapor, Atmos. Environ. 21, 1529-1539

Tabazadeh A, Cordero EC (2004): New Directions: Stratospheric ozone recovery in a changing atmosphere, Atmos. Environ. 38, 647-649

Tang IN (1976): Phase transformation and growth of aerosol particles composed of mixed salts, J. Aerosol Sci. 7, 361-371

Thouret V, Cammas JP, Sauvage B, Athier G, Zbinden R, Nedelec P, Simon P, Karcher F (2006): Tropopause referenced ozone climatology and inter-annual variability (1994-2003) from the MOZAIC programme, Atmos. Chem. Phys. 6, 1033-1051

Tolls J, McLachlan MS (1994): Partitioning o semivolatile organic compounds between air and Lolium multiflorum (welsh ray grass), Environ. Sci. Technol. 28, 159-166

Trapp S, Matthies M (1998): Chemodynamics and Environmental Modeling - An Introduction, Part 1: Textbook, Heidelberg/Germany (Springer)

Troe J (1979): Predictive possibilities of unimolecular rate theory, J. Phys. Chem. 83, 114-126

Vaghjiani GL, Ravishankara AR (1989): Absorption cross sections of CH_3OOH, H_2O_2, and D_2O_2 vapors between 210 nm and 365 nm at 297 K, J. Geophys. Res. 94, 3487-3492

van Dingenen R, Raes F, Putaud JP, Baltensperger U, Brüggemann E, Charron A, Facchini MC, Decesari S, Fuzzi S, Gehrig R, Hansson HC, Harrison RM, Hüglin C, Jones AM, Laj P, Lorbeer G, Maenhaut W, Palmgren F, Querol X, Rodriguez S, Schneider J, ten Brink H, Tunved P, Torseth K, Wehner B, Weingartner E, Wiedensohler A, Wahlin P (2004): A European aerosol phenomenology, Part 1: Physical characteristics of particulate matter at kerbside, urban, rural and background sites in Europe, Atmos. Environ. 38, 2561–2577

Vrekoussis M, Liakakou E, Mihalopoulos N, Kanakidou M, Crutzen PJ, Lelieveld J (2006): Formation of HNO_3 and NO_3^- in the anthropogenically-influenced eastern Mediterranean marine boundary layer, Geophys. Res. Lett. 33, Art. No. L05811

Wahner A, Moortgat GK (2007): Die Atmosphäre als photochemischer Reaktor, Chem. in unserer Zeit 41, 192-198

Wang H, Kostel JA, Amand ALS, Gray KA (1999): The response of a laboratory stream system to polychlorinate biphenyl exposure: Study of perophytic and sedimentary accumultion patterns, Water Res. 33, 3749-3761

Wania F, Mackay D (1993): Global fractionation and cold condensation of low volatility organic chlorine compounds in polar regions, Ambio 22, 10-18

Wania F, Mackay D (1995): A global distribution model for persistent organic chemicals, Sci. Total Environ. 161, 211-232

Wanninkhoff R (1992): Relationship between wind speed and gas exchange over the ocean, J. Geophys. Res. 97, 7373-7382

Warneck P (1986): The equilibrium distribution of atmospheric gases between the two phases of liquid water clouds, NATO ASI Ser. G6 (Jaeschke W, ed.), Heidelberg (Springer), pp. 473-499

Warneck P (1999): The relative importance of various pathways for the oxidation of sulfur dioxide and nitrogen dioxide in sunlit continental fair weather clouds, Phys. Chem. Chem. Phys. 1, 5471-5483

Warneck P (2000): Chemistry of the natural atmosphere (International Geophysics Vol. 71), San Diego (Academic Press), 2nd ed.

Warneck P (2003): In-cloud chemistry opens pathways to the formation of oxalic acid in the marine atmosphere, Atmos. Environ. 37, 2423-2427

Wennberg PO, Dabdub D (2008): Rethinking ozone production, Science 319, 1624-1625

Wesely ML, Hicks BB (1977): Some factors that affect the deposition rates of sulfur dioxide and similar gases on vegetation, J. Air Pollut. Control Assoc. 27, 1110–1116

Wexler AS, Seinfeld JH (1990): The distribution of ammonium salts among a size and composition dispersed aerosol. Atmos. Environ. 24A, 1231-1246

Winer AM, Biermann HW (1994): Long pathlength optical absorption spectroscopy (DOAS) meansurements of gaseous nitrous acid, nitrogen dioxide, and formaldehyde in the California South Coast Air Basin, Res. Chem. Intermediates 20, 423-445

Winkler P, Junge CE (1972): The growth of atmospheric aerosol particles as a function of the relative humidity – I. Method and measurements at different locations, J. Rech. Atmos. 6, 617-638

Winkler P (1974): Die relative Zusammensetzung des atmosphärischen Aerosols in Stoffgruppen, Meteor. Rdsch. 27, 129-136

WMO (1999) – World Meteorological Organisation: Environmental effects of ozone depletion and its interactions with climate change: 1998 Assessment, WMO, Geneva, http://ozone.unep.org/Publications/Assessment_Reports/

WMO (2007) – World Meteorological Organisation: Environmental Effects of Ozone Depletion and its interactions with Climate Change: 2006 Assessment, WMO, Geneva, http://ozone.unep.org/Publications/Assessment_Reports/

Zhou XL, Gao HL, Huang G, Bertman SB, Civerolo K, Schwab J (2003): HNO_3 photolysis on surfaces in low-NO_x environments: Significant atmospheric implications, Geophys. Res. Lett. 30, Art. No. 2217

Zuo Y, Hoigné J (1992): Formation of hydrogen peroxide and depletion of oxalic acid in atmospheric water by photolysis of Fe(III)-oxalato complexes, Environ. Sci. Technol. 26, 1014-1022